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Monitoring Report/Decision Summary for Operable Unit 3-13, Group 5, Snake River Plain Aquifer

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Prepared for the
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Idaho Operations Office

REVISION LOG

DOE/ID-11098

Monitoring Report/Decision Summary for Operable Unit 3-13,
Group 5, Snake River Plain Aquifer

This Revision Log documents revisions made to Rev. 0 of the OU 3-13 Group 5 MRDS (DOE/ID-11098). These changes will result in Rev. 1 of this document.

Rev.	Date	Affected Pages	Revision Description
1	12/20/04	Front cover and page i	Change “Revision 0, January 2004” to “Revision 1, December 2004.”
2	12/20/04	TOC	Revise Table of Contents to include Attachment 1– Long-Term Monitoring Plan for OU 3-13, Group 5, Snake River Plain Aquifer
3	12/20/04	Table 3-1	Add 2-page continuation to Table 3-1 that includes Problem Statement B (existing table only has Problem Statement A). The text for Problem Statement B was taken from DOE/ID-10782 (Rev. 2) and was revised slightly to show the correct figure references and to include Tc-99 and nitrate as COCs that have exceeded MCLs in the aquifer.
4	12/20/04	p. 8-1	Revise last two sentences of Section 8 (“Operations and Maintenance Plan”) as follows: “The Long-Term Monitoring Plan (Attachment 1) contains a list of wells to be sampled, constituents for which those samples will be analyzed, and details of the sample collection procedures. The Long-Term Monitoring Plan was revised during FY 2004 to reflect revisions to sampling frequencies and suites of analytes for individual SRPA monitoring wells.”
5	12/20/04	p. 10-2	Revise last page of references to change revision number of DOE-ID 2003d from Rev. 2 to Rev. 3, change the document date from March 2003 to August 2004, and change the citation in Section 8 to DOE-ID 2004 instead of DOE-ID 2003d.
6	12/20/04	Appendix E	Add new flysheet and insert new attachment as follows: Attachment 1 – Long-Term Monitoring Plan for OU 3-13, Group 5, Snake River Plain Aquifer (DOE/ID-10783, Rev. 3).

ABSTRACT

This Monitoring Report/Decision Summary serves as the remedial action report for Operable Unit 3-13, Group 5, Snake River Plain Aquifer at the Idaho Nuclear Technology and Engineering Center, located at the Idaho National Engineering and Environmental Laboratory near Idaho Falls, Idaho. This document provides an evaluation of the effectiveness of the selected remedial action for Group 5 (Institutional Controls with Monitoring and Contingent Remediation). Results are presented for a field investigation performed during 2002 to investigate the properties of the Snake River Plain Aquifer "HI interbed" (sediments between the "H" and "I" basalt flows). Groundwater monitoring results and trends for the aquifer through 2003 also are presented and summarized.

Based on the field and laboratory results of the HI interbed investigation, the groundwater contaminant transport model was revised. The model also included a revised estimate of the I-129 source term at the former Idaho Nuclear Technology and Engineering Center injection well. The revised model output more closely resembles the observed Snake River Plain Aquifer radionuclide contaminant plumes.

There is no need to invoke the contingent remedy (groundwater pump and treat) for Group 5. Based on the results of field investigations and revised groundwater modeling, it is anticipated that the Group 5 remedy will be successful in achieving the remedial action objectives established for the aquifer by the year 2095.

EXECUTIVE SUMMARY

This Monitoring Report/Decision Summary serves as the remedial action report for Operable Unit 3-13, Group 5, Snake River Plain Aquifer (SRPA) at the Idaho Nuclear Technology and Engineering Center, (INTEC), located at the Idaho National Engineering and Environmental Laboratory near Idaho Falls, Idaho. This document is a required submission as specified in the Remedial Design/Remedial Action Scope of Work for Waste Area Group 3, Operable Unit 3-13 (DOE-ID 2000) and is intended to assess the effectiveness of the selected remedial action for the SRPA groundwater contaminant plume associated with past operations at INTEC.

The remedy selected in the Final Record of Decision Idaho Nuclear Technology and Engineering Center, Operable Unit 3-13 (DOE-ID 1999) for Group 5 was Institutional Controls with Monitoring and Contingent Remediation (Alternative 2B). The Record of Decision also specified two remedial action objectives for the aquifer: (1) “Prior to 2095, prevent current on-site workers and general public from ingesting SRPA groundwater that exceeds a cumulative carcinogenic risk of l × 10-4, a total HI [hazard index] of 1, or applicable State of Idaho groundwater quality standards (i.e., MCLs)” and (2) “In 2095 and beyond, ensure that SRPA groundwater does not exceed a cumulative carcinogenic risk of l × 10-4, a total HI [hazard index] of 1, or applicable State of Idaho groundwater quality standards (i.e., MCLs).” The first remedial action objective is being met by maintaining institutional control over the area of the identified SRPA contaminant plume south of the current INTEC security fence for as long as contaminant levels remain above groundwater standards or risk-based groundwater concentrations. Groundwater monitoring and modeling have been performed to address the second remedial action objective (post-2095 risk).

Groundwater contaminant transport modeling performed in 1997 and revised in 2000 had predicted that elevated concentrations of I-129 and Sr-90 could possibly persist after 2095 in the low-hydraulic-conductivity HI sedimentary interbed south of INTEC (between the "H" and "I" basalt flows). However, groundwater quality data were not available for the HI interbed downgradient of INTEC to verify the presence or absence of contaminants in the interbed, or the physical properties of the interbed sediments themselves.

In order to fill this data gap, a plume evaluation (HI interbed) investigation was performed during July–November 2002. The field investigation included the following: (1) drilling of four new borings (ICPP-1795 through ICPP-1798) through the HI interbed; (2) collection of samples from above, within, and below the HI interbed for laboratory analysis of groundwater; and (3) collection of interbed sediment samples for analysis of geotechnical properties.

Based on the field and laboratory results of the HI interbed investigation, the groundwater contaminant transport model was revised. The model also included a revised estimate of the I-129 source term at the former INTEC injection well based on process knowledge. Appendix D contains an Engineering Design File report that documents the basis for the revised I-129 source term. The revised model output more closely resembles the radionuclide contaminant plumes that currently exist in the aquifer.

Groundwater monitoring results for monitor wells located downgradient (south) of INTEC were reviewed and summarized. These results show that, as of 2003, tritium and I-129 activities are already below their respective maximum contaminant levels (MCLs) in all SRPA monitor wells downgradient of INTEC. The I-129 groundwater plume has diminished considerably in both areal extent and in peak concentration over the period between 1986 and 2003. Coupled with the modeling results, the observed dissipation of the I-129 plume over the past 2 decades indicates that the remedial action objectives for this will be met before 2095.

Currently, Sr-90 activities in the aquifer exceed the MCL downgradient of INTEC, but Sr-90 concentrations are slowly declining in nearly all wells as a result of radioactive decay and dilution/dispersion. Groundwater quality trends indicate that Sr-90 activities in groundwater outside the INTEC security fence will decline below the MCL by 2095. However, perched water and vadose zone materials near the tank farm constitute a residual secondary source of Sr-90 that will be investigated and addressed under Operable Unit 3-14.

The remedy for Group 5 specified in the Record of Decision (Institutional Controls with Monitoring and Contingent Remediation) is operational and functional. Institutional controls are currently in place, and groundwater monitoring is being performed to ensure that the remedial action objectives for the aquifer are met. In addition, the infiltration of water through contaminated soils is being reduced in accordance with the Group 4 remedy (Institutional Controls with Aquifer Recharge Control).

Based on the decision logic established for Group 5, as well as the results of the plume evaluation field investigation, there is no need to invoke the contingent remedy (groundwater pump and treat). Furthermore, the results of groundwater sampling across the HI interbed have obviated the need for additional investigations (e.g., pumping tests, treatability studies), and the path forward for Group 5 consists of periodic plume monitoring. Both the groundwater monitoring results and the revised groundwater flow model presented in this report demonstrate that the I-129 hot spot that had previously been predicted in the HI interbed downgradient of INTEC most likely does not exist. Concentrations of all Group 5 radionuclide contaminants of concern are declining in the aquifer. Therefore, there is no reason to believe that the Group 5 remedy will not be successful in achieving the remedial action objectives established in the Record of Decision.

CONTENTS

FIGURES

TABLES

ACRONYMS

AA	alternative action
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFA	Central Facilities Area
COC	contaminant of concern
CPP	Chemical Processing Plant
DOE	Department of Energy
DQO	data quality objective
DS	decision statement
EDF	Engineering Design File
EPA	Environmental Protection Agency
FFA/CO	Federal Facility Agreement and Consent Order
FY	fiscal year
HLWE	high-level waste evaporator
ICDF	INEEL CERCLA Disposal Facility
INEEL	Idaho National Engineering and Environmental Laboratory
INTEC	Idaho Nuclear Technology and Engineering Center
LTMP	long-term monitoring plan
MCL	maximum contaminant level
MD	mean difference
MDA	minimum detectable activity
OU	operable unit
PSQ	principal study question
PVC	polyvinyl chloride
RAO	remedial action objective
RG	remediation goal

RI/BRA	remedial investigation/baseline risk assessment
RI/FS	remedial investigation/feasibility study
RMS	root mean square
ROD	Record of Decision
RPD	relative percent difference
RWMC	Radioactive Waste Management Complex
SPERT	Special Excursion Reactor Test
SRPA	Snake River Plain Aquifer
TAN	Test Area North
TBD	to be determined
TRA	Test Reactor Area
USC	United States Code
USGS	United States Geological Survey
WAG	waste area group
WCF	Waste Calcining Facility

Monitoring Report/Decision Summary for Operable Unit 3-13, Group 5, Snake River Plain Aquifer

1. INTRODUCTION

This Monitoring Report/Decision Summary serves as the remedial action report for Operable Unit (OU) 3-13, Group 5, Snake River Plain Aquifer (SRPA) at the Idaho Nuclear Technology and Engineering Center (INTEC), located at the Idaho National Engineering and Environmental Laboratory (INEEL) near Idaho Falls, Idaho. The remedial action report is a required submission under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (42 USC § 9601 et seq.) and is intended to assess the effectiveness of the selected remedial action for the SRPA groundwater contaminant plume associated with past operations at INTEC.

The INEEL is a U.S. Government-owned facility managed by the U.S. Department of Energy (DOE). The eastern boundary of the INEEL is 52 km (32 mi) west of Idaho Falls, Idaho. The INEEL Site occupies approximately 2,305 km2 (890 mi2) of the northwestern portion of the Eastern Snake River Plain in southeast Idaho. The INTEC facility covers an area of approximately 0.39 km2 (0.15 mi2) and is located approximately 72.5 km (45 mi) from Idaho Falls, in the south-central area of the INEEL (Figure 1-1). The INTEC has been in operation since 1952. Research, storage of spent nuclear fuel, and reprocessing spent nuclear fuel from defense-related projects for the recovery of enriched uranium were the plant's original missions. The DOE phased out the reprocessing operations in 1992 and redirected the plant's mission to (1) receive and temporarily store spent nuclear fuel and other radioactive waste for future disposition, (2) manage current and past waste, and (3) perform remedial actions.

Groundwater within the SRPA became contaminated as a result of past operations at the INEEL. Contaminant sources at INTEC include the former injection well that previously received low-level radioactive aqueous waste from plant processes (service waste), the former percolation ponds, and downward percolation of water through contaminated soil at the INTEC tank farm, where high-level liquid waste historically has been stored. The nature and extent of groundwater contamination downgradient of INTEC have been investigated for nearly 50 years, most recently as part of the CERCLA process. With respect to groundwater quality, the principal contaminants of concern (COCs) are radionuclides, including tritium, Sr-90, and I-129. Detailed information regarding previous groundwater investigations can be found in the Comprehensive RI/FS for the Idaho Chemical Processing Plant OU 3-13 at the INEEL—Part A, RI/BRA Report (Final) (DOE-ID 1997) and the Final Record of Decision Idaho Nuclear Technology and Engineering Center, Operable Unit 3-13 (DOE-ID 1999).

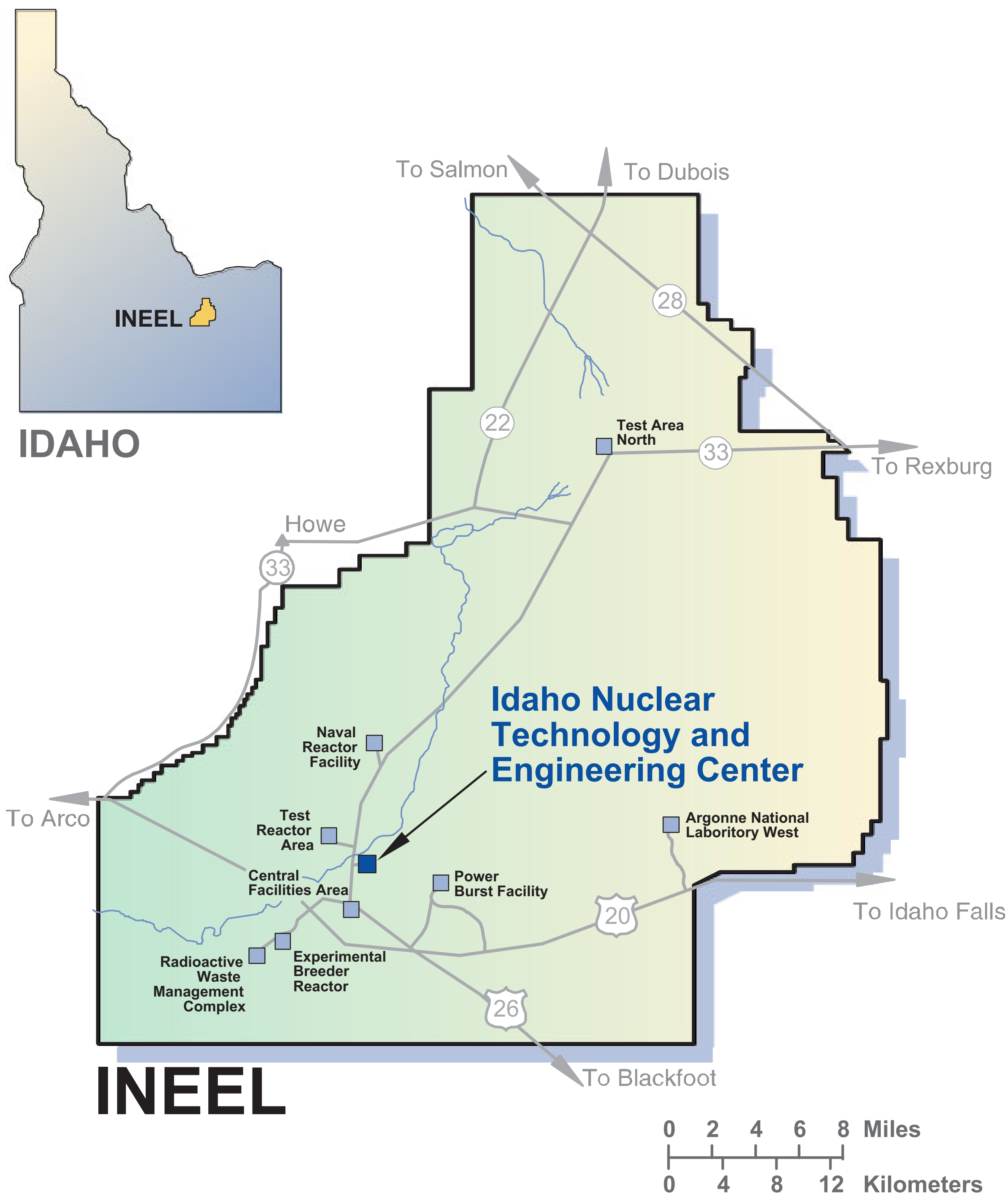

Figure 1-1. Map showing location of the INTEC at the INEEL.

2. REGULATORY BACKGROUND AND HISTORY

Under the Federal Facility Agreement and Consent Order for the Idaho National Engineering Laboratory (DOE-ID 1991), the U.S. Environmental Protection Agency (EPA), the Idaho Department of Environmental Quality, and the DOE (collectively known as the Agencies) are directing cleanup activities to reduce human health and environmental risks to acceptable levels at INTEC. In accordance with the Federal Facility Agreement and Consent Order (FFA/CO) (DOE-ID 1991), INTEC is designated as Waste Area Group (WAG) 3. In order to facilitate remediation of INTEC, WAG 3 was further divided into OUs that consist of individual contaminant release sites. The comprehensive remedial investigation/feasability study (RI/FS) for the INTEC facility was designated as OU 3-13, and the SRPA constitutes Group 5 of OU 3-13.

2.1 Remedial Action Objectives

The OU 3-13 Record of Decision (ROD) (DOE-ID 1999) evaluated various potential remedial actions for the SRPA, and, based on this assessment, the remedy selected for Group 5 was Institutional Controls with Monitoring and Contingent Remediation (Alternative 2B). The ROD specified two remedial action objectives (RAOs) for the aquifer outside the INTEC security fence: (1) "Prior to 2095, prevent current on-site workers and general public from ingesting SRPA groundwater that exceeds a cumulative carcinogenic risk of l × 10-4, a total HI [hazard index] of 1, or applicable State of Idaho groundwater quality standards (i.e., MCLs)" and (2) "In 2095 and beyond, ensure that SRPA groundwater does not exceed a cumulative carcinogenic risk of l × 10-4, a total HI [hazard index] of 1, or applicable State of Idaho groundwater quality standards (i.e., MCLs)."

The general actions required to meet the RAOs (post-2095) are spelled out in the OU 3-13 ROD (DOE-ID 1999). As stated in the ROD, the selected remedy (institutional controls with monitoring and contingent remediation) consists of three components:

- Maintaining existing and additional institutional controls over the area of the SRPA contaminant plume to prevent exposure to contaminated groundwater during the time the aquifer is expected to remain above maximum contaminant levels (MCLs)

- Groundwater monitoring to determine if SRPA groundwater COC concentrations exceed their action levels and if the impacted portion of the aquifer is capable of producing more than 0.5 gpm, which is considered the minimum drinking water yield necessary for the aquifer to serve as a drinking water supply

- Contingent active pump and treat remediation if the action levels are exceeded and production is greater than 0.5 gpm such that the modeled aquifer water quality will exceed the MCLs after 2095 in the SRPA outside the current INTEC security fence.

An interim action is selected for the SRPA. While the remediation of contaminated SRPA groundwater outside of the current INTEC security fence is final, the final remedy for the contaminated portion of the SRPA inside of the INTEC fence line is deferred to OU 3-14. As a result of dividing the SRPA, the groundwater contaminant plume associated with INTEC operations into two zones, the remedial action for OU 3-13 Group 5 is classified as an interim action. As required under CERCLA (42 USC § 9601 et seq.), 5-year reviews will be conducted until the Agencies determine they are no longer necessary. The 5-year reviews will evaluate the effectiveness of the selected remedial alternative or the need for the contingent remedial alternative.

2.2 Remediation Goals

Based on the RAOs, the OU 3-13 ROD (DOE-ID 1999) also established numerical remediation goals (RGs) for specific COCs in groundwater. The RGs for INTEC-derived COCs in groundwater outside the INTEC security fence are based on the applicable State of Idaho groundwater quality standards. The COCs listed in the OU 3-13 ROD (DOE-ID 1999) as having the potential to exceed groundwater standards after 2095 include Sr-90, I-129, and tritium. The post-2095 RGs for these beta-gamma-emitting radionuclides are established as the drinking water MCLs. The RGs (MCLs) and half-lives for these COCs are as listed in Table 2-1.

Table 2-1. Snake River Plain Aquifer remediation goals.

COC	Half-life (years)	SRPA Remediation Goalsa for Single COCs (pCi/L)
Tritium	12.3	20,000
Sr-90	29.1	8
I-129	15,700,000	1b

a. If multiple contaminants are present, use a sum of the fractions to determine the combined COCs' remediation goals. The total of beta-gamma-emitting radionuclides shall not exceed a 4-mrem/yr effective dose equivalent.

b. Derived concentration assuming COC is the only beta-gamma radionuclide present.

COC = contaminant of concern
SRPA = Snake River Plain Aquifer

2.3 Identification of Potential I-129 Hot Spot in HI Interbed

Two previous groundwater modeling efforts were performed prior to this report. Additional details regarding previous modeling efforts are included in Section 5 of this report and are summarized briefly below.

Groundwater modeling was performed in 1997 to assess whether the SRPA remediation goals would be predicted to be met by 2095. The results of this first groundwater modeling effort are summarized in the Remedial Investigation/Baseline Risk Assessment (RI/BRA) (DOE-ID 1997, Appendix F). The results of the RI/BRA modeling predicted that elevated concentrations of I-129 and Sr-90 might still remain in the low-hydraulic-conductivity HI sedimentary interbed. At that time, however, groundwater quality data were not available for the HI interbed downgradient of INTEC to verify the presence or absence of contaminants in the interbed.

The OU 3-13 RI/BRA aquifer model was updated during OU 3-13 Group 5 remedial actions (DOE-ID 2000). The aquifer model update attempted to more accurately simulate the HI interbed and the deep aquifer, and it also corrected a coding error in the earlier version of the computer code. Although the revised model predicted lower I-129 activities in the SRPA in the year 2095 than the previous RI/BRA model, the revised modeling results still showed the potential for I-129 concentrations to exceed the MCL of 1 pCi/L within the low-permeability HI interbed sediments. At that time, data were not yet available regarding groundwater quality within the HI interbed and the physical properties of the interbed sedimentary materials.

3. PLUME EVALUATION FIELD INVESTIGATION

In order to address the HI interbed data gaps discussed above, a drilling and sampling investigation was performed during 2002 to collect information that had been lacking on the HI interbed, and groundwater quality above, within, and below this horizon. The investigation was performed according to the Plume Evaluation Field Sampling Plan for Operable Unit 3-13, Group 5, Snake River Plain Aquifer (DOE-ID 2002a) and included drilling and sampling of four borings downgradient of INTEC. Locations of the four borings are shown in Figure 3-1. As detailed in the Plume Evaluation Field Sampling Plan (DOE-ID 2002a), decision criteria were established based on the results of vertical groundwater quality profiling in the four boreholes.

3.1 Data Quality Objectives

Data quality objectives (DQOs) developed for the HI interbed investigation were presented in the Plume Evaluation Field Sampling Plan (DOE-ID 2002a) and are reproduced here in Table 3-1. The DQO table outlines the principal study questions (PSQs), decision statements, and inputs to the decisions that support the Group 5 contingent remedy decision.

The decision logic for this investigation is shown schematically in Table 3-1. The flowchart outlines the steps to be taken to arrive at a contingent remedy decision and to perform the SRPA interim monitoring. These two separate flow paths are identified on the chart. As shown on the left portion of the flowchart, the results of the field investigation described in this section determine the need for additional investigations (e.g., pumping tests, treatability studies), as well as the decision of whether to implement the contingent Group 5 remedy.

3.2 Field Investigation

The OU 3-13, Group 5 Plume Evaluation (HI interbed) Investigation included four new borings (ICPP-1795 through ICPP-1798) drilled to investigate groundwater quality above, within, and below the HI interbed, and to collect samples of the interbed materials for analysis of geotechnical properties. Boring locations are shown on Figure 3-1. The locations were selected based on the results of I-129 contaminant transport modeling (DOE-ID 2002a). Drilling operations began on July 18, 2002, and drilling and sampling were completed on November 14, 2002. Following is a summary of field activities and investigation results. Appendix A includes "End-of-Well Reports" that contain additional details of drilling and well construction activities.

3.2.1 Interbed Sampling Methods

Sediment core samples were collected from the HI interbed for geophysical and chemical analysis. An attempt was made to collect samples from the top, the center, and from the bottom of the interbed at each of the four boring locations. Additional interbed samples were collected from the ICPP-1798 borehole because of the greater thickness encountered at this location.

The HI interbed was cored with an "H" or "P" sized diamond-impregnated, face discharge core bit using water as a drilling fluid. The core barrel was lined with an appropriate sized Lexan liner for the bit size being used. The Lexan liner and sediment sample were recovered with a wireline system, and the core samples were cut into 6-in. lengths, sealed, and submitted to the laboratory for geophysical testing. In addition, a subsample of the interbed sedimentary material collected from the interior of the core sample was placed into proper sample containers for submittal to the analytical laboratories for chemical analysis as specified in the Plume Evaluation Field Sampling Plan (DOE-ID 2002a).

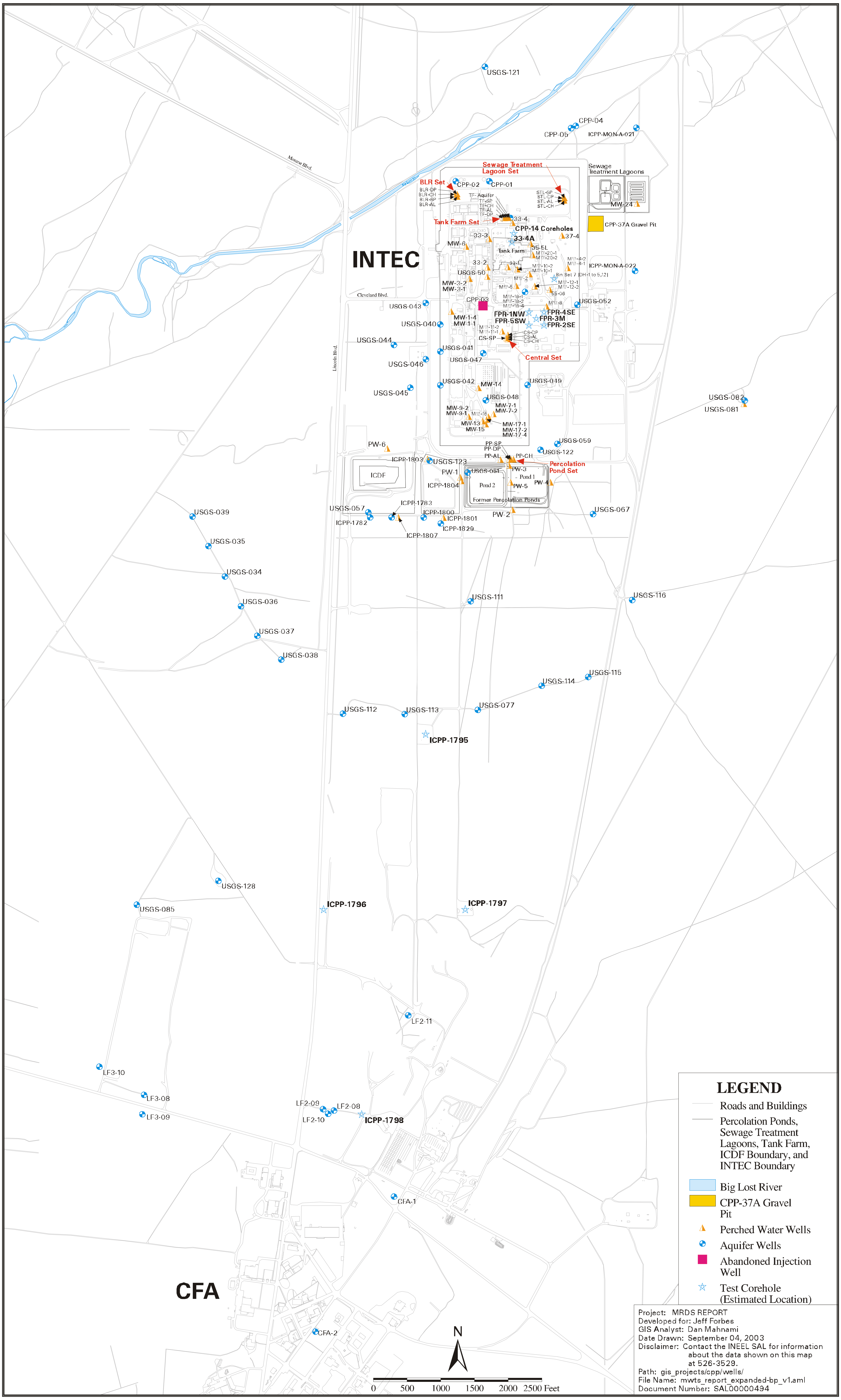

Figure 3-1. Location of monitor wells and borings.

Table 3-1. Data quality objectives table, Operable Unit 3-13, Group 5, Snake River Plain Aquifer.

Problem Statement A: HI Interbed Contingent Remedy Decision					
1. State the Problem	2. Identify the Decision			3. Identify Inputs to the Decision	4. Define the Study Boundaries
	Principal Study Questions	Alternative Actions	Decision Statement		
Problem Statement A: Empirical data are required to support evaluation of the WAG 3 SRPA numerical model to determine if we continue to predict a risk to future groundwater users in 2095 and beyond due to I-129 potentially present in the HI sedimentary interbed. Note: Modeling of the SRPA for the WAG 3 RI/FS predicted a future risk to groundwater users due to high concentrations of I-129 predicted to be present in the low-hydraulic-conductivity HI sedimentary interbed in the year 2095 and beyond. However, no empirical data are available to confirm the physical properties of the HI interbed as assumed in the WAG 3 model nor are there any data regarding the presence or absence of high concentrations of I-129 in the interbed. Empirical evidence is required to evaluate the model predictions and determine whether or not an acceptable risk from I-129 is predicted to exist in 2095 and beyond.	PSQ-1: Are COC concentration action levels exceeded in the model-predicted hot spot of the groundwater contaminant plume outside of the INTEC security fence? Note: The action level(s) is based on groundwater modeling and will correspond to COC concentrations that will not exceed risk concentrations greater than 1 × 10-4 or MCLs in the year 2095. The COC concentration data will be obtained from the HI interbed and surrounding basalts during the field-sampling program anticipated to occur in FY 2001. Modeling predictions are required to determine if these action levels will be exceeded in 2095. The combined COC action level for H-3, Sr-90, and I-129 (beta-gamma-emitters) is 4 mrem/yr in the year 2095.	AA-1: Alternatives to PSQ-1 include proceeding to actions required to answer PSQ-3 or lapsing into SRPA monitoring.	DS-1: Determine whether COC concentration action levels are exceeded in the model-predicted hot spot downgradient of INTEC requiring additional evaluation of the aquifer water yield from the hot spot.	The following are inputs to PSQ-1: 1. Groundwater model sensitivity analysis of the HI sedimentary interbed characteristics, to identify key variables, related to HI interbed for long-term predictions of COC concentrations 2. Establishing four new wells/boreholes in the I-129 hot spots for groundwater and sedimentary interbed sampling 3. Physical characteristics of the HI sedimentary interbed (TBD will be identified in the aquifer model sensitivity analysis) to support model refinement and COC concentration predictions 4. Borehole geophysical and fluid logging of new wells for location of sampling depths 5. Vertical profile sampling (straddle packer) of new wells/boreholes and existing wells for COC concentrations at, above, and below the HI interbed 6. One sampling round of 47 aquifer monitoring wells for I-129, H-3, and Sr-90 to support model refinement and COC concentration predictions 7. Model refinement and updated prediction of COC concentrations in 2095 and beyond.	This study will focus on physical characteristics of the HI sedimentary interbed and peak concentrations and distribution of groundwater COCs within the SRPA groundwater contaminant plume south of INTEC. The purpose of the study is to determine if the WAG 3 RI/FS aquifer model is correct in predicting that there will be an unacceptable risk to residential groundwater users outside of the INTEC fence line in excess of 1 × 10-4 (or COCs exceeding MCLs) in the year 2095 and beyond. The potential risk is primarily from I-129, which is predicted by the aquifer model to reside in the HI interbed at concentrations exceeding the RG. The spatial boundary of this study is limited to the area defined as Group 5, SRPA, under the OU 3-13 ROD (DOE-ID 1999). This encompasses that portion of the SRPA outside of the INTEC security fence bounded by the groundwater contaminant plume that exceeds Idaho groundwater quality standards of the federal MCLs for I-129, H-3, or Sr-90. Based upon the WAG 3 groundwater model, the area of particular interest within this boundary is an I-129 hot spot south of INTEC in the vicinity of Well USGS-113. (Note: This may be refined by prefield testing sensitivity analysis of HI interbed in the WAG 3 aquifer model.) The estimated depth of the HI interbed in this area is between 100 and 140 ft below the water table, though the aquifer above, within, and below the HI interbed is included in this study. The base of the study area will be the first high permeability zone in the I basalt below the HI interbed, but not to exceed 100 ft below base of HI interbed. The hot spot is predicted to exist within the HI sedimentary interbed below the water table at this location. However, to date, empirical evidence has not been collected that supports the existence of this hot spot, nor has a sensitivity analysis been performed on the WAG 3 model's representation of the HI interbed that resulted in the prediction. It should be noted that practical constrains on the collection of soil and groundwater samples (i.e., poor sample recovery, limitation on packer deployment in rubble, or cavernous zones) may limit our ability to sample the interbed or SRPA in general at certain zones. This study will be used to determine if contingent groundwater remediation is required to reduce the risk to future groundwater users in the year 2095 and beyond. Thus, the current decision of whether to implement the contingent remedy will rely on predicted concentrations of COCs, as calculated by the refined WAG 3 aquifer model. Institutional controls will be in place before 2095 to prevent residential use of groundwater exceeding MCLs or 1 × 10-4 risk concentrations.
	PSQ-2: Do zones, which exceed COC action levels identified in PSQ-1, yield a sustained flow of greater than 0.5 gpm for a period of 24 hours?	AA-2: Alternatives to PSQ-2 included proceeding to actions required to answer PSQ-3 or lapsing into SRPA monitoring.	DS-2: Determine if the hot spot will yield a groundwater flow rate of 0.5 gpm for a period of 24 hours.	If the COC action levels are exceeded in PSQ-1, then the following will be inputs to PSQ-2: 1. A 24-hour/0.5-gpm pumping test(s) of the zones that were identified in PSQ-1 as having COC(s) exceeding action level(s) 2. Sampling of the COC(s) during the pumping test.	
	PSQ-3: Does the hot spot exceed the volume-action level such that a residential water user may pump from the hot spot for a period of more than 1 year?	AA-3: Alternatives to PSQ-3 include proceeding on to the contingent remedy and aquifer monitoring or just lapsing into SRPA monitoring.	DS-3: Determine if the hot spot is of sufficient size/volume to require contingent remediation.	If required, the following will be inputs to PSQ-3: 1. An analytical or model-derived volume action level 2. Evaluation of the COC hot spot volume through the creation of iso-surface maps to calculate the estimated volume.	

Table 3-1. (continued).

Problem Statement A: HI Interbed Contingent Remedy Decision		
5. Develop a Decision Rule	6. Specify Tolerable Limits on Decision Errors	7. Optimize the Design
DS-1: If any COC exceeds its action level at any sampling zone, then we must determine if the aquifer at that zone is also capable of producing a sustained yield of 0.5 gpm for a period of 24 hours. If COC action levels are not exceeded at any sampling location then we will proceed with SRPA monitoring (i.e., periodic monitoring).	TBD	A flow chart presenting the conceptual design of the WAG 3, Group 5, field activities is attached as Figure 3-2 titled, "Structure map showing the top of the HI interbed." The flow chart details the steps to be taken to both arrive at a contingent remedy decision and to perform the SRPA interim monitoring. The two separate flow paths are identified on the chart. The following paragraphs describe and present the rationale for the design of field activities related to the contingent remedy decision. The Group 5 decision to collect additional COC concentrations, and SRPA and interbed data before making a decision on implementation of the contingent remedy, is based on the need to evaluate the WAG 3 RI/FS model predictions of elevated I-129 concentrations in the SRPA, including the HI interbed, in 2095 and beyond. Because no physical characteristics or COC concentration data were available from the HI interbed to confirm the model predictions, and no sensitivity analysis has been performed, we must collect empirical data on the presence of I-129 in the SRPA and physical properties of the HI interbed south of INTEC to support refinement of the groundwater model. Given the basis for the field activities, before conducting the field activities, available field data will be reviewed and a sensitivity analysis on the HI interbed assumptions will be performed. This activity will be performed to identify hydrologic data gaps, which will be incorporated in the final sampling and analysis plan for the Group 5 contingent remedy decision. Based upon the RI/FS hot spot modeling and the Monitoring System and Installation Plan (DOE-ID 2003a) hot spot modeling, four additional wells/boreholes will be constructed. The wells will be drilled in a manner that allows for the collection of sedimentary interbed samples from the HI interbed for analysis of physical characteristics and COC concentrations. Following drilling, borehole geophysical and fluid logging will be performed on the newly deepened and constructed wells (and three existing wells selected for profiling) to identify sampling locations for COC vertical profile sampling. The geophysical logging will consist of natural gamma, caliper, deviation, and video logging. Borehole fluid logging will consist of borehole flow, temperature, and specific conductivity. These logs will be reviewed before groundwater sample collection to identify the specific zones within each borehole for sampling. Groundwater sampling will be conducted using a packer system and sampling pump to isolate the specific zone being sampled. Except for the interbed sample, one sample will be collected from each sampling zone. Because of concerns about borehole collapse or sloughing in the interbed, groundwater samples from the interbed will be collected during drilling. The borehole will be extended approximately 5 ft into the interbed and the first sample will be taken using a single packer system and will consist of packing off the basalt at the interbed basalt interface. A bottom packer will not be used for interbed sampling. To guard against equipment getting trapped in the hole, the pump will be placed above the packer and a screen placed below the packer in the interbed. Replicate samples for Tc-99 and I-129 will be collected during interbed sampling. The replicate Tc-99 samples will be analyzed and the replicate I-129 sample held in storage until the results are determined for the I-129 and Tc-99 samples. The replicate samples will be analyzed for Tc-99 to confirm the original sample results. If I-129 is above the action level, the replicate I-129 sample from the interbed will be analyzed. Following sample collection and analysis, the data will be reviewed to determine if the COC action levels are exceeded in any sampling zone. If the COC action level is exceeded in a zone, the zone will again be isolated with packers and pumped for a period of 24 hours to determine if the zone will yield groundwater at a rate of 0.5 gpm for the duration of the test. One water sample will be collected every 4 hours during pumping to determine if the COC action levels also are exceeded throughout the pumping test. If COC action levels are exceeded and the aquifer at the sampling zone(s) yields a sustained 0.5 gpm for a 24-hr period, isopleth maps will be developed from the COC concentration data to estimate the volume of the hot spot(s). It is possible that additional wells may be required to estimate the hot spot volume. If additional wells are determined necessary, they will be drilled and then tested in the same manner as described above. The final volume estimates will be compared to the model-derived volume action level to determine if it has been exceeded. These results will be reported in the Group 5 Monitoring Report/Decision Summary. To assist in the model evaluation and COC predictions discussed above, and to up date information on COC plume dynamics subsequent to the 1991 USGS sampling event, samples will be collected from the existing aquifer monitoring well network and analyzed for COC concentrations. This sampling will provide additional data to support model predictions of how the aquifer is performing outside of the HI interbed and support refinement of the model predictions. A first round of sampling will be performed, including the full INTEC monitoring network (47 wells), with subsequent annual monitoring performed on a limited set of wells (approximately 20) specifically identified to support an updated aquifer model calibration. Following completion of the Monitoring Report/Decision Summary, periodic monitoring of the WAG 3 groundwater plume(s) outside of the INTEC security fence line will be implemented. This periodic monitoring of the plumes will be performed concurrent with the INTEC facility monitoring.
DS-2: If the aquifer is capable of producing 0.5 gpm for a period of 24 hours from a zone, which also exceeds COC action levels, then we must determine the volume of the hot spot. If the zone does not produce 0.5 gpm for 24 hours then we will proceed with SRPA monitoring.		
DS-3: If the volume of the COC hot spot is sufficiently large that a future groundwater user could pump from the hot spot for a period of more than 1 year, then we are required to proceed with the contingent remedy. If the hot spot does not exceed the volume action level, then we will proceed with SRPA monitoring.		

AA = alternative action
COC = contaminant of concern
DS = decision statement
FY = fiscal year
INTEC = Idaho Nuclear Technology and Engineering Center
MCL = maximum contaminant level
OU = operable unit
PSQ = principal study question
RG = remediation goal
RI/FS = remedial investigation/feasibility study
ROD = Record of Decision
SRPA = Snake River Plain Aquifer
TBD = to be determined
USGS = United States Geological Survey
WAG = waste area group

Table 3-1. (continued).

Problem Statement B: INTEC Facility Monitoring					
1. State the Problem	2. Identify the Decision			3. Identify Inputs to the Decision	4. Define the Study Boundaries
	Principal Study Questions	Alternative Actions	Decision Statement		
Problem Statement B: Monitor the flux of contaminants in the aquifer across the INTEC security fence line and downgradient of the facility to determine if the Group 5 RAO of achieving Idaho groundwater quality standards or risk-based concentrations by 2095 will be affected by contamination within the INTEC facility. OU 3-13 Group 5 is defined as the portion of the SRPA outside of the INTEC security fence where concentrations of COCs exceed current MCLs or risk-based concentrations. The remediation goal for OU 3-13, Group 5, is "Achieving the applicable State of Idaho groundwater standards or risk-based groundwater concentrations in the SRPA plume south of the INTEC security fence by the year 2095" (ROD, Section 8.1.5, pages 8—10). To determine if this goal will be met, the input of contaminants to Group 5 from the contaminated aquifer within the INTEC security fence must be determined.	PSQ-1: Is the COC flux in the SRPA from the contaminated media in the vadose zone beneath the INTEC facility of sufficient magnitude to prevent achieving the Group 5 remediation goals?	No alternative actions required for monitoring program	DS-1: Determine whether or not the flux of contaminants in the SRPA which originate in the vadose zone within the INTEC security fence line is of sufficient magnitude to exceed the Group 5 remediation goals in 2095.	The inputs to PSQ-1 are: Sampling of selected wells upgradient of, near the boundary of, and within the INTEC security fence line and analysis for COCs. Selected wells will be sampled in the upper 50 ft of the SRPA. Measurement of water table elevations for evaluation of groundwater elevation contours and flow direction. Periodic incorporation of new data and update of the WAG 3 OU 3-13 aquifer numerical model for prediction of COC concentrations in the SRPA at 2095 and beyond.	This study will focus on the SRPA beneath the INTEC facility and near the boundary of the facility. The area of focus along the INTEC boundary is the south and west boundaries given the south-southwest direction of groundwater flow in this region. The primary sources of contaminants to the aquifer include both the perched water/vadose zone above SRPA and the former injection well which penetrates the aquifer and HI interbed. Two principal study questions have been identified to evaluate these sources separately. The portion of the aquifer that is likely to be affected by contaminants transported through the vadose zone is the upper 50 ft of the aquifer above the HI interbed. Because the former injection well penetrated the HI interbed, the portion of the aquifer potentially affected by the injection well includes both the upper zone from the water table to the HI interbed and the lower zone beneath the HI interbed. The total depth of the former injection well was 598 ft. Accordingly the base of the study boundary should correspond to the total depth of injection, or approximately 600 ft below land surface. Monitoring the concentrations of COCs above and below the HI interbed and as far downgradient as indicated by the detections of COCs above MCLs. Because the remediation goal is established in the year 2095, this study will continue through the institutional control period to at least 2095.
	PSQ-2: Is the COC flux in the SRPA from the contaminated sediments/sludges remaining in the former ICPP injection well (CPP-23) and immediate vicinity of sufficient magnitude to prevent achieving the Group 5 remediation goal?	No alternative actions required for monitoring program.	DS-2: Determine whether or not the flux of contaminants in the SRPA from the former INTEC injection well is of sufficient magnitude to exceed the Group 5 remediation goals in 2095.	The inputs to PSQ-2 are: 1. Borehole geophysical and fluid logging of selected wells which penetrate the HI interbed for selection of wells and sampling zones below the HI interbed for selection of wells and sampling zones below the HI interbed downgradient of the former injection well. 2. Isolation through packers or other method(s), sampling, and analysis for COCs of selected well zones below the HI interbed downgradient of the former injection well. 3. Measurement of water table elevations for evaluation of groundwater elevation contours and flow directions, and possibly head gradient between aquifer above and below the HI interbed. 4. Periodic incorporation of new data and update of the WAG 3 OU 3-13 aquifer numerical model for prediction of COC concentrations in the SRPA at 2095 and beyond. NOTE: *Isolation of sampling zone(s) beneath the HI interbed depth from selected wells should not preclude also sampling of zone(s) above the HI interbed from the same well to supply inputs for PSQ-1.*	
	PSQ-3: Are the COC concentrations in the SRPA outside the INTEC facility at sufficient magnitude to prevent achieving the Group 5 remediation goals?	No alternative actions required for monitoring program.	DS-3: Determine whether or not the COCs in the SRPA outside the INTEC facility will exceed the Group 5 remediation goals in 2095.	The inputs to PSQ-3 are: Sampling of selected wells downgradient of the INTEC security fence and analysis for COCs. Selected wells will monitor contaminants above MCLs and monitor the downgradient plume area above MCLs. Measurement of water elevations for evaluation of groundwater elevation contours and flow direction. Periodic incorporation of new data into the OU 3-13 aquifer numerical model for the predication of COC concentrations in the SRPA in 2095 and beyond.	

Table 3-1. (continued).

5. Develop a Decision Rule	6. Specify Tolerable Limits on Decision Errors	7. Optimize the Design
If the monitoring activities and model predictions generated for this study indicate that Group 5 RAOs/remedial goals will be exceeded due to the flux of contaminants in the SRPA beneath or downgradient of the INTEC facility, a comprehensive evaluation, focused feasibility study, and ROD amendment will be performed to address the risks posed by groundwater contaminants beneath INTEC and/or downgradient of INTEC. If it is determined that the RAOs/remedial goals will be met, monitoring will continue until 2095 or until the agencies determine that no unacceptable risk exists from Group 5. Note: The decision is based upon model predictions using data obtained from an observational well network to model evolution of the plume.	In this case, the decisions will be made by comparing data to computer predictions, the accuracy of the computer predictions will be dependent on the accuracy of the OU 3-13 model	A flow chart presenting the conceptual design of the WAG 3 Group 5 remedy is shown in Figure 7-2. The flow chart details the steps to be taken to both arrive at a contingent remedy decision and to perform the SRPA interim monitoring. The two separate flow paths are identified on the chart. The following paragraphs describe and present the rationale for the design of field activities related to the contingent remedy decision. Thirty-six wells are available in the vicinity of INTEC suitable for groundwater monitoring. From that set of wells, 11 are selected for the INTEC facility monitoring program to support PSQ-1, monitoring of the contaminant input from the vadose zone to the SRPA. The PSQ-1 INTEC facility monitoring shall consist of groundwater sample collection from wells located upgradient of, within, and adjacent to the INTEC facility. The wells selected for monitoring include MW-18, USGS-40, USGS-42, USGS-47 through -49, USGS-51, USGS-52, and USGS-122 through USGS-123 (Figure 3-1). One well, USGS-121, was selected upgradient of the contaminant source areas at INTEC to provide background groundwater quality data. Though this well is not directly upgradient of the INTEC facility, it is located nearer to the groundwater flow paths from potential sources of upgradient contamination (TRA or NRF) than other wells and is, in that respect, well suited for providing upgradient water quality data. Several wells were selected inside the INTEC facility (MW-18, USGS-47, USGS-48, USGS-49, and USGS-52) to help distinguish between the possible sources of groundwater contaminants located throughout the INTEC facility. Wells USGS-40, USGS-42, USGS-51, USGS-122, and USGS-123 were selected because they are located along the southern and western boundaries of INTEC. The general direction of groundwater flow beneath INTEC is interpreted to be to the south-southwest. The three wells selected for monitoring in support of PSQ-2, former injection well monitoring, are USGS-41, USGS-48, and USGS-59 based upon an evaluation of their suitability for monitoring the aquifer below the HI interbed. There are 12 USGS wells in the vicinity of INTEC and the former injection well that penetrate the HI interbed and remain as open boreholes in the aquifer, potentially suitable for long-term monitoring of the aquifer beneath the HI interbed (excluding INTEC production wells which are required for facility support and cannot be modified to sample below the HI interbed). The wells are USGS-40 through-49, USGS-51, USGS-52, and USGS-59. These wells are located either cross-gradient or downgradient of the former injection well. An evaluation of available data from and additional geophysical and borehole fluid logging of these wells will be performed to determine if they are suitable for deep sampling and to identify potential zones for sampling. It should be noted that an upgradient monitoring well which penetrates the HI interbed is not available within the existing monitoring well network at INTEC. Well USGS-121 does not penetrate the HI interbed. Production wells CPP-1, CPP-2, and CPP-4 have been drilled through the HI interbed and have perforated well casing both above and below the HI interbed but are of limited use as monitoring wells based upon their required support of INTEC operations. The need for an upgradient monitoring well in this zone will be evaluated after the monitoring program is initiated. If the data obtained from the facility monitoring program indicate that the injection well secondary source may cause or contribute to not meeting the Group 5 RAO/ remediation goals, an upgradient well will be installed for sampling beneath the HI interbed to ensure that an upgradient source is not present. In addition to the above monitoring, one sampling round will be conducted using the entire INTEC monitoring network at the onset of the activities outlined in the LTMP. This sampling event will provide a “snapshot” of the current state of the contamination of the SRPA in the vicinity of the INTEC facility and provide a data set to compare the COC flux monitoring data. In addition, these data will be used to update the OU 3-13 numerical aquifer model. In support of Group 4 activities, groundwater samples collected during the baseline sampling event from USGS-40, -42, -47, -48, -49, -51, -121, -122, -123, and MW-18 will be analyzed for stable isotopes including oxygen, hydrogen, and nitrogen. In addition to the analytes listed below, metals and anions will be included in the semiannual and micropurge sampling. Six wells have been selected for long-term monitoring of the INTEC plume beyond the facility boundary in support of PSQ-3. The wells selected for long-term monitoring are USGS-57, USGS-67, USGS-112, USGS-113, USGS-85, and LF3-08. These wells were selected based on a review of the historical data for I-129. However, most of the data used to select these wells for long-term monitoring is from 1990–1991; therefore, the baseline groundwater sampling data will be used to optimize the well locations and the total number of wells for long-term monitoring. Analytes of interest include COCs which currently exist in the SRPA at concentrations exceeding either MCLs or risk-based concentrations as well as COCs derived from the modeling which are predicted to potentially cause a future unacceptable risk to the SRPA. Contaminants that have exceeded MCLs or risk-based concentrations and will be included in the INTEC facility monitoring program are I-129, H-3, Tc-99, Sr-90, and nitrate. Contaminants that are predicted by the WAG 3 RI/FS modeling to exceed MCLs or risk-based concentrations at a future date and are included in the INTEC facility monitoring program are plutonium and uranium isotopes, Np-237, Am-241, and mercury. Chromium, while listed as a COC, is excluded because it is specifically related to groundwater contamination at TRA. Also, because Tc-99 is a contributor to total beta-emitting radionuclides limit and present at significant concentrations in the aquifer beneath INTEC, it is included in the list of analytes for INTEC facility monitoring. To evaluate additional radionuclides that may be present but not accounted for in the modeling, gross-alpha and gross-beta analyses will also be performed. Finally, the list of analytes will be updated through either the exclusion of some analytes or inclusion of additional analytes as analytical data are accumulated or new information regarding contaminant sources is identified. Sampling and analyses will occur at the following frequency: Year 1 — Baseline and Semiannual — Gross-alpha/beta, Hg, tritium, Tc-99, I-129, Sr-90, plutonium isotopes (Pu-238, -239, -240, and –241), uranium isotopes (U-234, -235, and -238), Am-241, Np-237, Cs-137; metals and anions in semiannual and micropurge sampling only. Years 2–7 — Annual — Gross-alpha/beta, Hg, tritium, Tc-99, I-129, Sr-90, plutonium isotopes (Pu-238, -239, -240, and –241), uranium isotopes (U-234, -235, and –238), Am-241, Np-237, Cs-137 Years 8–16 — Biannual (once every two years) — Review and adjust as required Years 17–100 — Once every 5 years — Review and adjust as required Following each sampling event and prior to each CERCLA 5-year review, the new groundwater sampling results will be compared against the OU 3-13 aquifer model predictions to determine if concentrations are above, at, or below the model-predicted trends. If the new data indicate the model must be updated, the model will be updated generating new COC concentration predictions. These predictions will be compared against the Group 5 RAO/ remediation goals to determine if they will be exceeded or not. If the data trends exceed model-predicted trends and indicate a potential exceedance of the Group 5 RAO/remediation goals, the sampling frequency will revert to annual sampling and progress in a manner similar to the schedule above.

AA = alternative action
COC = contaminant of concern
DS = decision statement
FY = fiscal year
INTEC = Idaho Nuclear Technology and Engineering Center
MCL = maximum contaminant level
OU = operable unit
PSQ = principal study question
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RI/FS = remedial investigation/feasibility study
ROD = Record of Decision
SRPA = Snake River Plain Aquifer
TBD = to be determined
USGS = United States Geological Survey
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3.2.2 Results for HI Interbed Soil Samples

A total of 13 HI interbed soil samples were analyzed to determine the activities of selected radionuclides, as well as for geotechnical properties. The results of these laboratory tests are summarized below.

The HI interbed samples collected during the plume evaluation investigation were analyzed for tritium, Sr-90, I-129, as well as gross alpha and gross beta radiation. Table 3-2 lists the sample depths at each boring location and the laboratory analytical results for each sample. Based on the laboratory results, key findings for soil samples are as follows:

- Iodine-129 was not detected in any of the soil samples. All results were qualified with "U" or "UJ" flags at minimum detectable activity (MDA) values ranging from 0.25 to 0.36 pCi/g.

- Tritium was not detected in any of the soil samples (all results qualified with "U" flags at MDA values ranging from 3.9 to 19.5 pCi/g).

- Strontium-90 was not detected in any of the soil samples (all results qualified with "U" or "UJ" flags at MDA values ranging from 0.14 to 0.29 pCi/g).

3.2.3 HI Interbed Structure

Table 3-3 shows the depth and thickness of the HI interbed at each borehole location. Figure 3-2 is a structure map showing the elevation of the top of the HI interbed near INTEC, and Figure 3-3 is an isopach map of the HI interbed thickness. In general, the interbed elevation decreases to the southeast, and interbed thickness increases toward the southeast. The thickness of the HI interbed ranges from zero at some locations directly beneath INTEC to 65 ft at USGS-20, which is located approximately 8,000 ft southeast of the INTEC southern boundary (Figure 3-3).

3.2.4 Geotechnical Properties of HI Interbed Sediments

Daniel B. Stephens & Associates, Inc. performed the geotechnical analyses of the sediment core samples from Boreholes ICPP-1795 through ICPP-1798. The samples were analyzed for porosity, hydraulic conductivity, and grain size distribution. The results of these analyses will be used to refine the OU 3-13 RI/FS groundwater flow model (Section 5 and Appendix B). Results of the geotechnical tests are shown in Table 3-4. Because the split-barrel sampler was incapable of obtaining core samples of some of the gravelly interbed sediments encountered in the boreholes, the finer-grained interbed material was preferentially sampled. Therefore, it is likely that the hydraulic conductivities shown in Table 3-4 are biased low.

Daniel B. Stephens & Associates, Inc. also assigned American Society for Testing and Materials and United States Department of Agriculture soil classifications for the sediment samples. These soil classifications, as well as the United Soil Classification symbols inferred from the laboratory data, are listed in Table 3-5.

Table 3-2. Soil chemistry.

Location	Depth (ft)	Sample Number	Date Sample Collected	Gross Alpha				Gross Beta				Iodine-129				Tritium				Sr-90			
				Result (pCi/g)	Result Uncertainty (+/-1 sigma)	Qualifier Flag	MDA (pCi/g)	Result (pCi/g)	Result Uncertainty (+/-1 sigma)	Qualifier Flag	MDA (pCi/g)	Result (pCi/g)	Result Uncertainty (+/-1 sigma)	Qualifier Flag	MDA (pCi/g)	Result (pCi/g)	Result Uncertainty (+/-1 sigma)	Qualifier Flag	MDA (pCi/g)	Result (pCi/g)	Result Uncertainty (+/-1 sigma)	Qualifier Flag	MDA (pCi/g)
ICPP-1795 INT-1	588.0–588.7	5HI06201	09/03/2002	19.50	3.23	—	5.39	48.80	1.21	J	3.74	0.00	0.05	UJ	0.29	-0.19	1.26	U	4.28	0.05	0.07	U	0.29
ICPP-1795 INT-2	591.9–592.3	5HI06301	09/03/2002	21.40	2.93	—	3.93	30.10	0.97	J	2.82	0.11	0.05	UJ	0.31	-0.45	1.14	U	3.90	0.01	0.06	U	0.28
ICPP-1796 INT-1	606.5–607.5	5HI01401	09/27/2002	8.42	2.24	—	6.40	21.60	1.15	—	7.75	0.08	0.08	UJ	0.36	-4.80	4.66	U	16.30	-0.01	0.06	U	0.29
ICPP-1796 INT-2	615–620	5HI01501	09/30/2002	13.70	2.51	—	4.10	31.40	1.41	—	7.11	0.23	0.06	UJ	0.33	-8.46	5.55	U	15.60	0.00	0.05	U	0.23
ICPP-1796 INT-3	626–628	5HI01601	09/30/2002	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.00	0.05	U	0.23
ICPP-1797 INT-1	605.0–605.5	5HI03001	10/16/2002	20.90	3.08	—	4.16	39.80	1.12	J	3.19	0.02	0.07	UJ	0.31	-2.53	1.39	U	4.88	-0.06	0.02	U	0.15
ICPP-1797 INT-2	607	5HI03101	10/17/2002	28.50	4.21	—	5.19	31.00	1.41	J	3.88	-0.05	0.06	UJ	0.25	-2.73	1.34	U	4.72	0.07	0.04	U	0.14
ICPP-1797 INT-3	614	5HI03201	10/17/2002	22.90	3.44	—	5.24	33.60	1.18	J	3.72	-0.03	0.04	UJ	0.27	-3.34	1.41	U	5.01	0.00	0.03	U	0.14
ICPP-1798 INT-1	620.5–622.0	5HI04601	9/11/2002	15.50	3.05	—	6.38	27.90	1.50	—	7.06	0.02	0.05	UJ	0.30	1.06	5.72	U	19.50	0.14	0.06	UJ	0.25
ICPP-1798 INT-2	626–628	5HI04701	9/18/2002	19.10	2.78	—	4.91	28.00	1.50	—	7.02	-0.09	0.07	UJ	0.31	3.83	4.34	U	14.50	—	—	—	—
ICPP-1798 INT-2 (lower)	636	5HI04701 (RB)	10/24/2002	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	0.08	0.04	UJ	0.15
ICPP-1798 INT-3	656	5HI04801	10/24/2002	14.00	2.59	—	4.42	27.30	1.05	J	3.33	-0.04	0.06	UJ	0.29	-3.30	1.42	U	5.03	0.11	0.04	UJ	0.15
ICPP-1798 INT-4	661	5HI14101	10/24/2002	17.50	3.09	—	5.91	32.60	1.08	J	3.76	0.06	0.05	UJ	0.29	-3.12	1.47	U	5.21	-0.02	0.03	U	0.14
ICPP-1798 INT-5	676	5HI14201	10/30/2002	25.30	4.19	—	6.23	52.50	1.30	J	3.37	-0.05	0.06	UJ	0.29	-4.18	1.27	U	4.59	0.00	0.03	U	0.14

ICPP = Idaho Chemical Processing Plant
MDA = minimum detectable activity

3.2.5 Aquifer Sampling Methods

Groundwater samples were collected from discrete depths within the SRPA in each of the four boreholes using an inflatable packer system. Groundwater sample depths are listed in Table 3-6. The configuration of the straddle-packer sampling system is shown in Figure 3-4.

Groundwater sample depths were selected based on review of geophysical logs (caliper, natural gamma, neutron, gamma-gamma, and temperature logs) and downhole video logs. Fracture zones were targeted for groundwater sampling, with tighter, more massive basalt zones above and below selected for the packer seal zones. In addition, two less productive zones were selected in the first borehole (ICPP-1797) to determine if massive basalt zones would produce sufficient groundwater for sampling and to test the effectiveness of the packer system seal against the borehole wall.

The groundwater sampling procedure at each sample depth was as follows. A Baski 3.4-in. uninflated packer was placed above and below the pump intake. A Grunfos Redi-Flo 3 pump was used with a single-phase 220-volt pump motor and field generator. The pump and packer system were lowered to the proper depth in the borehole on a 1-in.-diameter galvanized steel pump riser pipe. The packers were then inflated with compressed nitrogen gas. The pump was then turned on, and the isolated portion of the borehole between the packers was purged at flow rates of 3.5 to 5 gal per minute, depending on pump depth. The sample interval between the two packers was purged of a minimum of three volumes of groundwater. Following purging of at least three sample interval volumes, groundwater samples were collected after the groundwater temperature had stabilized.

For those boreholes for which duplicate groundwater samples were required, the primary sample was collected first, and the duplicate sample was collected at the end of sampling. This enabled comparison of the results for samples collected at the beginning and the end of the sampling process.

Table 3-3. HI interbed depth and thickness.

Borehole/Well Location	Depth of HI Interbed Below Surface (ft bls)	Elevation of Top of HI Interbed (ft)	Thickness of HI Interbed (ft)
ICPP-1795	587	4,340	7
ICPP-1796	605	4,331	27
ICPP-1797	601	4,328	16
ICPP-1798	621	4,315	57
USGS-128	612	4,323	35

ICPP = Idaho Chemical Processing Plant
USGS = United States Geological Survey

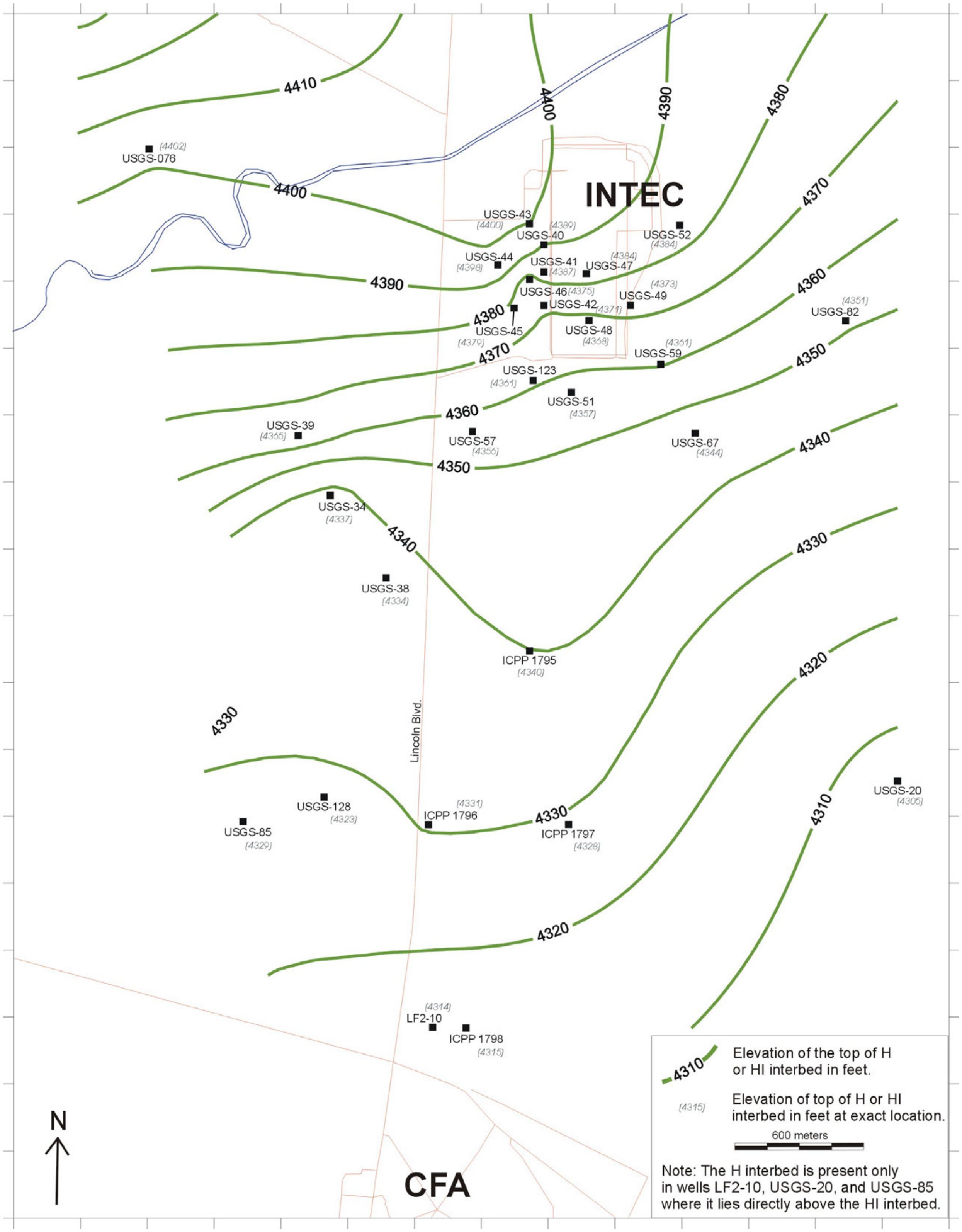


Figure 3-2. Structure map showing the top of the HI interbed.

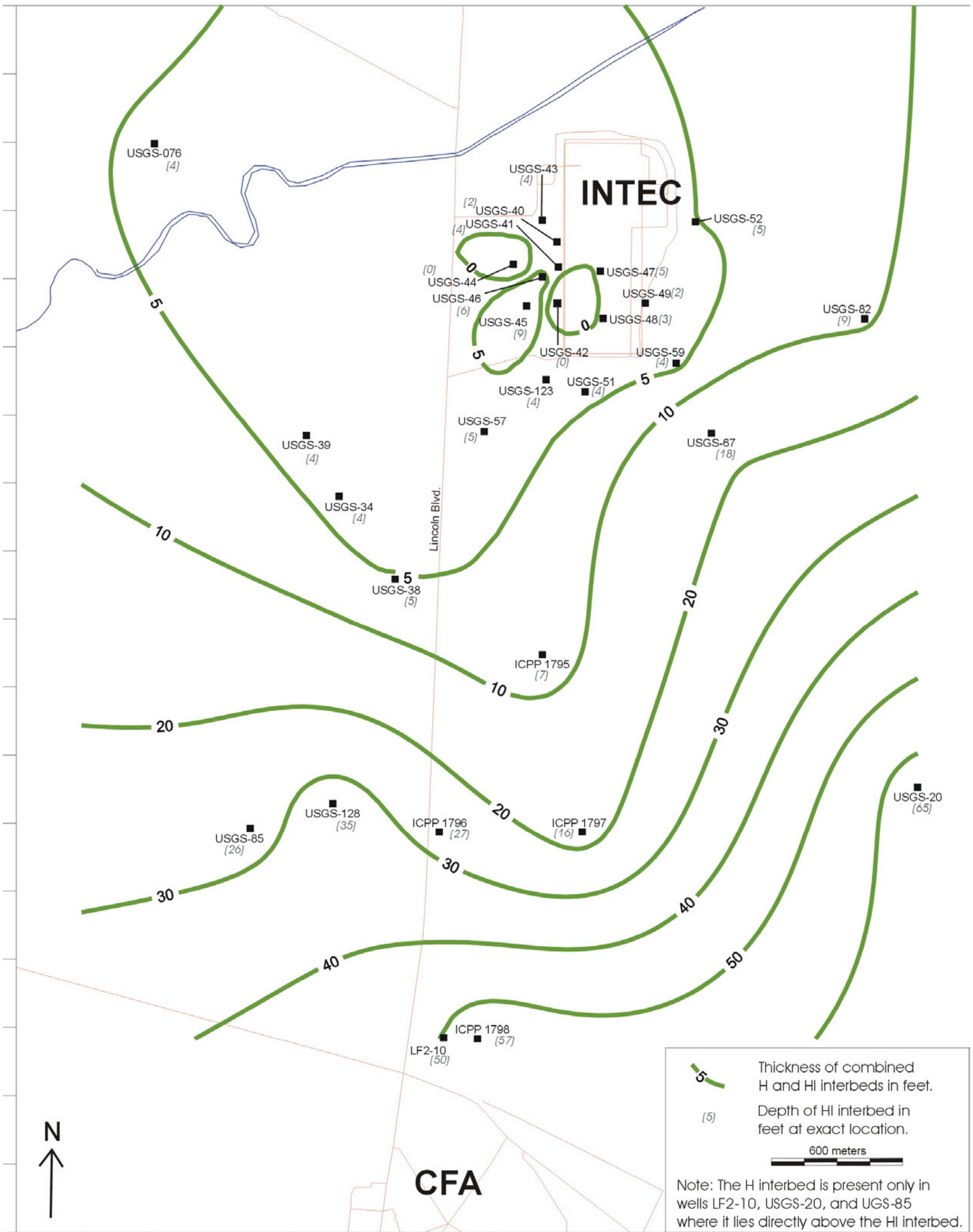


Figure 3-3. Isopach map showing the thickness of HI interbed.

Table 3-4. Geotechnical results for core samples of HI interbed.

Borehole Number	Sample Depth (ft)	Porosity (%)	Ksat (cm/sec)	d10 (mm)	d50 (mm)	d60 (mm)	Cu	Cc	Sample Number	Date Collected
ICPP-1795	591.0–591.9	49.9	9.80E-08	0.00056	0.018	0.083	148	0.31	5HI06201GX	9/3/02
ICPP-1795	593.8–594.2	31.6	2.30E-07	0.00042	0.16	0.22	524	46	5HI06301GX	9/3/02
ICPP-1796	615–620	NA	NA	0.25	3.2	4.2	17	1.6	5HI01501GX	9/30/02
ICPP-1796	626–628	NA	NA	0.11	0.16	0.18	1.6	0.85	5HI01601GX	9/30/02
ICPP-1797	604–605	42.9	1.20E-02	0.12	0.28	0.32	2.7	0.94	5HI03001GX	10/16/02
ICPP-1797	607	NA	NA	0.18	5.1	6.5	36	0.43	5HI03101GX	10/17/02
ICPP-1797	614	33.8	8.30E-04	0.0012	0.16	0.31	258	1.3	5HI03201GX	10/17/02
ICPP-1798	621.0–621.5	NA	NA	0.0065	0.1	0.2	31	0.69	5HI04601GX	9/11/02
ICPP-1798	626–628	NA	NA	0.15	0.38	0.44	2.9	1.3	5HI04701GX	9/18/02
ICPP-1798	656	43.1	6.50E-05	0.0047	0.15	0.18	38	12	5HI04801GX	10/24/02
ICPP-1798	661	39.3	1.40E-03	0.12	0.3	0.38	3.2	0.79	5HI14101GX	10/24/02

Cu = d60/d10
Cc = d302/(d10)(d60)
d50 = median particle diameter
Ksat = hydraulic conductivity
ICPP = Idaho Chemical Processing Plant
NA = sample not available, could not obtain undisturbed sample of coarse-grained material for analysis.

Table 3-5. Soil texture classification of HI interbed sediments.

Borehole Number	Sample Depth (ft)	American Society for Testing and Materials Classification	United States Department of Agriculture Classification	Unified Soil Classificatio n System	Sample Number	Date Collected
ICPP-1795	591.0–591.9	Classification requires Atterberg test.	Loam (est)	ML	5HI06201GX	9/3/02
ICPP-1795	593.8–594.2	Classification requires Atterberg test.	Sandy loam (est)	SC	5HI06301GX	9/3/02
ICPP-1796	615–620	Poorly graded sand with gravel	NA	SW	5HI01501GX	9/3/02
ICPP-1796	626–628	Poorly graded sand	Sand	SP	5HI01601GX	9/3/02
ICPP-1797	604–605	Poorly graded sand	Sand	SP	5HI03001GX	10/16/02
ICPP-1797	607	Poorly graded gravel with sand	NA	GP	5HI03101GX	10/17/02
ICPP-1797	614	Classification requires Atterberg test.	Sandy loam (est)	SC	5HI03201GX	10/17/02
ICPP-1798	621.0–621.5	Classification requires Atterberg test.	Silty sand	SM	5HI04601GX	9/11/02
ICPP-1798	626–628	Poorly graded sand	Sand	SP	5HI04701GX	9/18/02
ICPP-1798	656	Classification requires Atterberg test.	Loamy sand	SC	5HI04801GX	10/24/02
ICPP-1798	661	Poorly graded sand with gravel	NA	SP	5HI14101GX	10/24/02
ICPP-1798	676	Classification requires Atterberg test.	Silt loam (est)	ML	5HI14201GX	10/30/02

Est = reported values for d10, Cu, Cc, and soil classification are estimates, since extrapolation was required to obtain the d10 diameter.
NA = not applicable

Table 3-6. Groundwater sampling intervals and depths.

Borehole	Sample Series Number	Sample Description	Depth to Bottom of Upper Packer (ft)	Depth to Top of Lower Packer (ft)	Length of Sampling Interval (ft)
ICPP-1795	5HI049	Zone 1	578.7	593.6	14.9
ICPP-1795	5HI050	Zone 2	558.1	573.0	14.9
ICPP-1795	5HI051—Dry	Dry	494.7	509.6	14.9
ICPP-1795	5HI051—Dry	Dry	511.8	526.7	14.9
ICPP-1795	5HI051—Dry	Dry	533.9	548.8	14.9
ICPP-1795	5HI058	Zone 10	608.4	623.3	14.9
ICPP-1795	5HI059	Above	558.1	573.0	14.9
ICPP-1795	5HI060	Below	608.4	623.3	14.9
ICPP-1795	5HI061	Within	578.7	593.6	14.9
ICPP-1796	5HI01	Zone 1	604.0	613.0	9
ICPP-1796	5HI02	Zone 2	a	487.0	a
ICPP-1796	5HI03	Zone 3	489.7	504.6	14.9
ICPP-1796	5HI04—Dry	Dry	516.0	530.9	14.9
ICPP-1796	5HI010	Zone 10	632.0	663.0	31
ICPP-1796	5HI011	Above	489.7	504.6	14.9
ICPP-1796	5HI012	Below	632.0	663.0	31
ICPP-1796	5HI013	Within	604.0	613.0	9
ICPP-1797	5HI017	Zone 1	589.3	604.2	14.9
ICPP-1797	5HI018	Zone 2	a	503	a
ICPP-1797	5HI019	Zone 3	506.3	521.2	14.9
ICPP-1797	5HI020	Zone 4	522.4	537.3	14.9
ICPP-1797	5HI021	Zone 5	551.6	566.5	14.9
ICPP-1797	5HI022	Zone 6	578.2	593.1	14.9
ICPP-1797	5HI026	Zone 10	629.0	b	b
ICPP-1797	5HI027	Above	a	503	a
ICPP-1797	5HI028	Below	629.0	b	b
ICPP-1797	5HI029	Within	589.3	604.2	14.9
ICPP-1798	5HI033	Zone 1	604.0	613.0	9
ICPP-1798	5HI034	Zone 2	a	507	a
ICPP-1798	5HI035	Zone 3	510.8	525.7	14.9
ICPP-1798	5HI036	Zone 4	527.9	542.8	14.9
ICPP-1798	5HI037	Zone 5	552.6	567.5	14.9
ICPP-1798	5HI038	Zone 6	573.2	588.1	14.9
ICPP-1798	5HI042	Zone 10	699.0	b	b
ICPP-1798	5HI043	Above	552.1	567.0	14.9
ICPP-1798	5HI044	Below	699.0	b	b
ICPP-1798	5HI045	Within	604.0	613.0	9

a. No upper packer was used. Sample zone is from the water table to the lower packer.

b. No lower packer was used. Sample zone is from the upper packer to the bottom of the well.
ICPP = Idaho Chemical Processing Plant

Figure 3-4. Straddle packer and pump configurations.

3.2.6 Groundwater Sampling Results

The water samples collected from ICPP-1795, ICPP-1796, ICPP-1797, and ICPP-1798 were analyzed to determine the activities of tritium, Sr-90, I-129, and Tc-99, as well as gross alpha and gross beta radiation. Groundwater results are summarized in Table 3-7. Radionuclide depth profiles are shown in Figures 3-5 through 3-8. For each borehole, the depth profiles show the observed radionuclide activities in groundwater samples collected above, within, and below the HI interbed. Drinking water MCLs also are shown for comparison. Groundwater quality results for each radionuclide of concern are summarized below.

Table 3-7. Groundwater quality results.

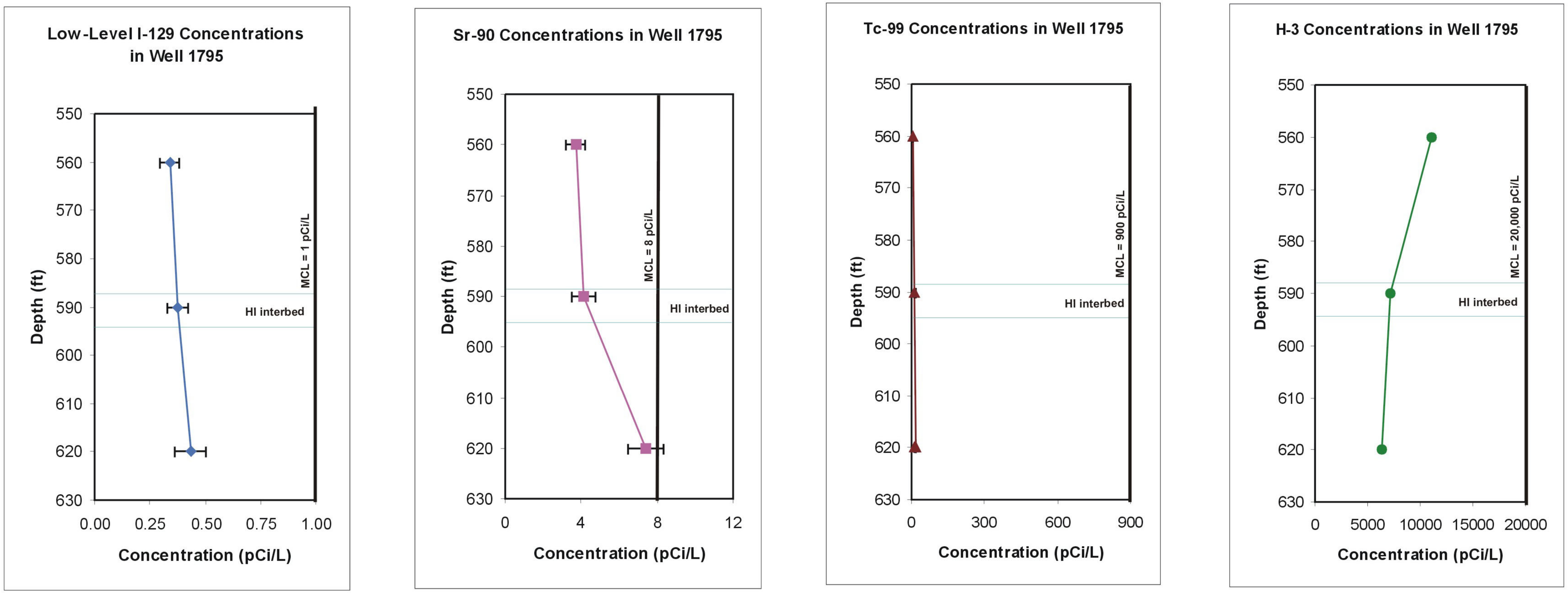
Location	Depth (ft)	Zone	Sample Number	Date Sample Collected	I-129 Result (pCi/L)	I-129 Result Uncertainty (+/- 1 sigma)	I-129 Qualifier Flag	I-129 MDA (pCi/L)	Tc-99 Result (pCi/L)	Tc-99 Result Uncertainty (+/- 1 sigma)	Tc-99 Qualifier Flag	Tc-99 MDA (pCi/L)	Sr-90 Result (pCi/L)	Sr-90 Result Uncertainty (+/- 1 sigma)	Sr-90 Qualifier Flag	Sr-90 MDA (pCi/L)	Tritium Result (pCi/L)	Tritium Result Uncertainty (+/- 1 sigma)	Tritium Qualifier Flag	Tritium MDA (pCi/L)
ICPP-1795	558–573	Z-2	5HI05001	10/9/02	0.59	0.36	U	0.72	—	—	—	—	3.72	0.50	—	0.59	11,100	317	—	445
ICPP-1795	558–573	Above interbed	5HI05901	10/9/02	0.34	0.04	—	0.14	6.95	1.44	J	4.59	—	—	—	—	—	—	—	—
ICPP-1795	558–573	Above interbed	5HI05902	10/9/02	—	—	—	—	6.92	1.55	J	4.99	—	—	—	—	—	—	—	—
ICPP-1795	579–594	Z-1	5HI04901	10/9/02	1.26	0.47	UJ	1.47	—	—	—	—	4.11	0.62	—	0.73	7,170	261	—	440
ICPP-1795	579–594	Within interbed	5HI06101	10/9/02	0.38	0.05	—	0.15	13.70	1.93	—	6.03	—	—	—	—	—	—	—	—
ICPP-1795	579–594	Within interbed	5HI06102	10/9/02	—	—	—	—	14.10	1.90	—	5.94	—	—	—	—	—	—	—	—
ICPP-1795	608–623	Z-10	5HI05801	10/9/02	0.00	0.28	U	1.07	—	—	—	—	7.41	0.92	—	0.59	6,370	254	—	454
ICPP-1795	608–623	Below interbed	5HI06001	10/9/02	0.43	0.07	—	0.22	17.70	1.70	—	5.15	—	—	—	—	—	—	—	—
ICPP-1795	608–623	Below interbed	5HI06002	10/9/02	—	—	—	—	13.40	1.58	—	4.88	—	—	—	—	—	—	—	—
ICPP-1796	485a–487	Z-2	5HI00201	10/7/02	0.00	0.51	U	1.39	—	—	—	—	8.33	1.06	—	0.62	6,380	253	—	450
ICPP-1796	485a–487	Z-2	5HI00202	10/7/02	0.57	0.26	UJ	0.68	—	—	—	—	8.86	1.18	—	0.67	5,400	218	—	392
ICPP-1796	490–505	Z-3	5HI00301	10/7/02	0.00	0.41	U	1.20	—	—	—	—	7.94	1.05	—	0.80	6,080	279	—	520
ICPP-1796	490–505	Above Interbed	5HI01101	10/7/02	0.58	0.10	—	0.32	25.50	1.60	—	4.53	—	—	—	—	—	—	—	—
ICPP-1796	490–505	Above Interbed	5HI01102	10/7/02	0.66	0.08	—	0.24	27.00	1.61	—	4.53	—	—	—	—	—	—	—	—
ICPP-1796	604–613	Within interbed	5HI01301	9/27/02	0.56	0.05	—	0.13	25.40	2.01	—	5.92	—	—	—	—	—	—	—	—
ICPP-1796	604–613	Within interbed	5HI01302	9/27/02	—	—	—	—	25.00	2.26	—	6.77	—	—	—	—	—	—	—	—
ICPP-1796	604–613	Z-1	5HI00101	9/27/02	1.05	0.48	UJ	1.45	—	—	—	—	3.74	0.56	—	0.79	5,970	275	—	515
ICPP-1796	632–663	Below interbed	5HI01201	10/3/02	0.04	0.01	UJ	0.06	-2.85	1.82	U	6.24	—	—	—	—	—	—	—	—
ICPP-1796	632–663	Below interbed	5HI01202	10/3/02	—	—	—	—	-4.22	2.20	U	7.56	—	—	—	—	—	—	—	—
ICPP-1796	632–663	Z-10	5HI01001	10/3/02	-0.48	0.37	U	1.23	—	—	—	—	0.20	0.21	U	0.91	1,690	190	—	507
ICPP-1797	472a–503	Z-2	5HI01801	11/13/02	1.74	0.62	U	0.80	—	—	—	—	5.35	0.77	—	0.80	7,330	273	—	272
ICPP-1797	472a–503	Above Interbed	5HI02701	11/13/02	0.88	0.08	J	0.20	28.70	2.24	—	6.27	—	—	—	—	—	—	—	—
ICPP-1797	472a–503	Above Interbed	5HI02702	11/13/02	—	—	—	—	39.40	2.91	—	8.04	—	—	—	—	—	—	—	—
ICPP-1797	506–521	Z-3	5HI01901	11/13/02	0.74	0.25	UJ	0.92	—	—	—	—	4.61	0.56	—	0.43	7,150	270	—	273
ICPP-1797	522–537	Z-4	5HI02001	11/13/02	1.28	0.54	UJ	1.43	—	—	—	—	5.09	0.65	—	0.51	7,000	268	—	274
ICPP-1797	552–567	Z-5	5HI02101	11/13/02	0.08	0.32	U	1.23	—	—	—	—	1.90	0.27	—	0.39	7,840	281	—	271
ICPP-1797	578–593	Z-6	5HI02201	11/14/02	0.28	0.35	U	1.26	—	—	—	—	1.15	0.40	UJ	1.43	8,400	291	—	271
ICPP-1797	589–604	Z-1	5HI01701	11/14/02	0.17	0.38	U	1.34	—	—	—	—	4.48	0.55	—	0.44	6,930	266	—	274
ICPP-1797	589–604	Within interbed	5HI02901	11/14/02	0.73	0.06	J	0.16	30.90	2.76	—	7.91	—	—	—	—	—	—	—	—
ICPP-1797	589–605	Within interbed	5HI02902	11/14/02	—	—	—	—	33.20	2.89	—	8.25	—	—	—	—	—	—	—	—
ICPP-1797	629–648b	Below interbed	5HI02801	10/18/02	0.33	0.05	J	0.14	22.80	2.83	—	8.15	—	—	—	—	—	—	—	—

Table 3-7. (continued).

Location	Depth (ft)	Zone	Sample Number	Date Sample Collected	I-129 Result (pCi/L)	I-129 Result Uncertainty (+/- 1 sigma)	I-129 Qualifier Flag	I-129 MDA (pCi/L)	Tc-99 Result (pCi/L)	Tc-99 Result Uncertainty (+/- 1 sigma)	Tc-99 Qualifier Flag	Tc-99 MDA (pCi/L)	Sr-90 Result (pCi/L)	Sr-90 Result Uncertainty (+/- 1 sigma)	Sr-90 Qualifier Flag	Sr-90 MDA (pCi/L)	Tritium Result (pCi/L)	Tritium Result Uncertainty (+/- 1 sigma)	Tritium Qualifier Flag	Tritium MDA (pCi/L)
ICPP-1797	629–648[b]	Below interbed	5HI02802	10/18/02	—	—	—	—	22.10	2.89	—	8.39	—	—	—	—	—	—	—	—
ICPP-1797	629–648[b]	Z-10	5HI02601	10/18/02	0.55	0.38	U	1.49	—	—	—	—	5.46	0.72	—	0.32	4,010	142	—	290
ICPP-1798	480a–507	Z-2	5HI03401	11/8/02	0.73	0.36	U	1.38	—	—	—	—	0.31	0.12	UJ	—	8,080	289	—	277
ICPP-1798	511–526	Z-3	5HI03501	11/8/02	0.76	0.38	UJ	1.19	—	—	—	—	0.18	0.10	U	0.39	8,460	292	—	271
ICPP-1798	528–543	Z-4	5HI03601	11/8/02	0.31	0.64	U	0.89	—	—	—	—	-0.07	0.11	U	0.55	7,820	283	—	275
ICPP-1798	552–568	Z-5	5HI03701	11/8/02	0.25	0.30	U	1.19	—	—	—	—	0.08	0.12	U	0.48	7,970	287	—	277
ICPP-1798	552–567	Z-5	5HI03702	11/8/02	0.82	0.32	UJ	1.37	—	—	—	—	-0.01	0.08	U	0.42	8,600	296	—	274
ICPP-1798	552–567	Above Interbed	5HI04301	11/8/02	0.59	0.07	J	0.19	12.50	2.07	—	6.41	—	—	—	—	—	—	—	—
ICPP-1798	552–567	Above Interbed	5HI04301	11/8/02	—	—	—	—	9.82	2.13	—	6.73	—	—	—	—	—	—	—	—
ICPP-1798	573–588	Z-6	5HI03801	11/8/02	0.17	0.64	U	1.16	—	—	—	—	0.12	0.10	U	0.44	8,960	304	—	277
ICPP-1798	604–613	Within interbed	5HI04501	10/28/02	0.03	0.01	UJ	0.05	0.49	2.47	U	8.36	—	—	—	—	—	—	—	—
ICPP-1798	604–613	Within interbed	5HI04502	10/28/02	—	—	—	—	4.12	2.58	U	8.48	—	—	—	—	—	—	—	—
ICPP-1798	604–613	Z-1	5HI03301	10/28/02	0.63	0.39	U	1.42	—	—	—	—	0.62	0.24	UJ	0.73	5,590	159	—	284
ICPP-1798	699–724b	Below interbed	5HI04401	11/5/02	0.00	0.02	U	0.07	9.38	2.69	—	8.53	—	—	—	—	—	—	—	—
ICPP-1798	699–724b	Below interbed	5HI04402	11/5/02	—	—	—	—	9.72	2.79	—	8.84	—	—	—	—	—	—	—	—
ICPP-1798	699–724b	Z-10	5HI04201	11/5/02	0.03	0.37	U	1.25	—	—	—	—	1.45	0.24	J	0.42	2,620	122	—	283

a. No upper packer. Sample zone is from the water table to the lower packer.

b. No lower packer. Sample zone is from the upper packer to the bottom of borehole.
ICPP = Idaho Chemical Processing Plant
MDA = minimum detectable activity



LL I-129 Concentrations in Well 1795

Depth (ft)	Result (pCi/L)	Flag
560	0.34+/-0.04	
590	0.38+/-0.05	
620	0.43+/-0.07	

Sr-90 Concentrations in Well 1795

Depth (ft)	Result (pCi/L)	Flag
560	3.72+/-0.50	
590	4.11+/-0.62	
620	7.41+/-0.92	

Tc-99 Concentrations in Well 1795

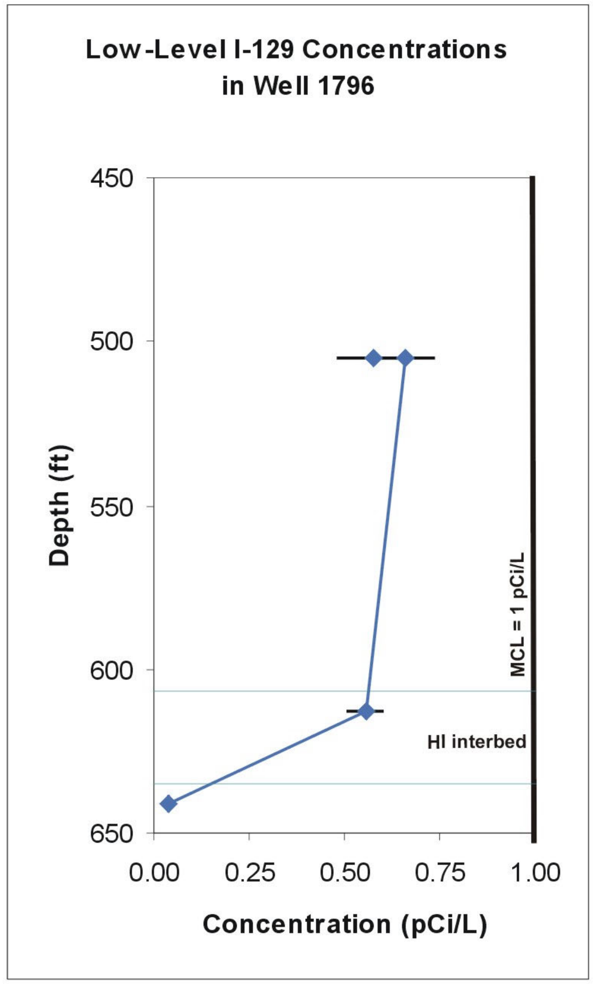
Depth (ft)	Result (pCi/L)	Flag
560	6.95+/-1.44	J
560	6.92+/-1.55	J
590	13.7+/-1.93	
590	14.1+/-1.9	
620	17.7+/-1.7	
620	13.4+/-1.58	

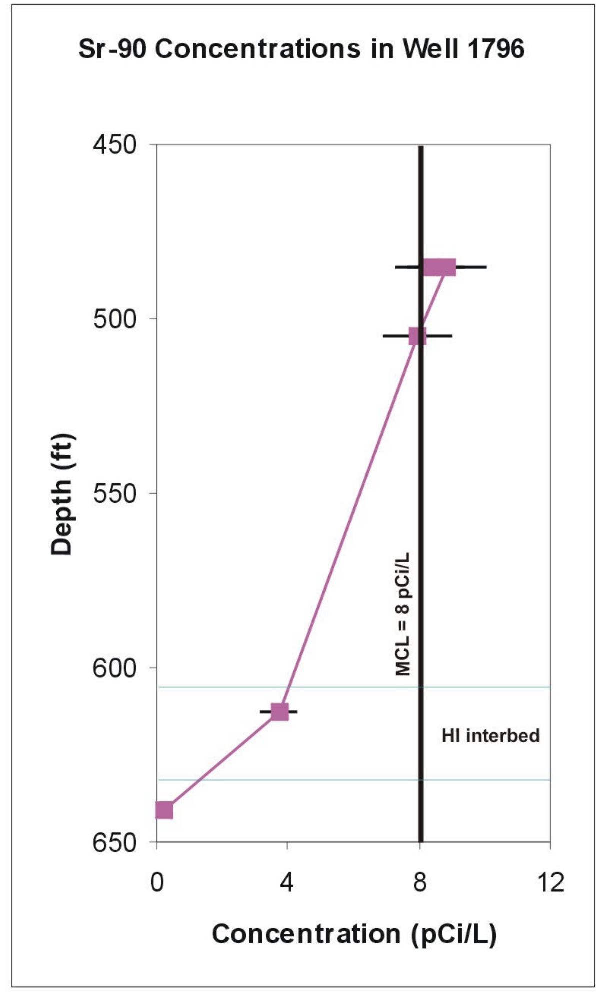
H-3 Concentrations in Well 1795

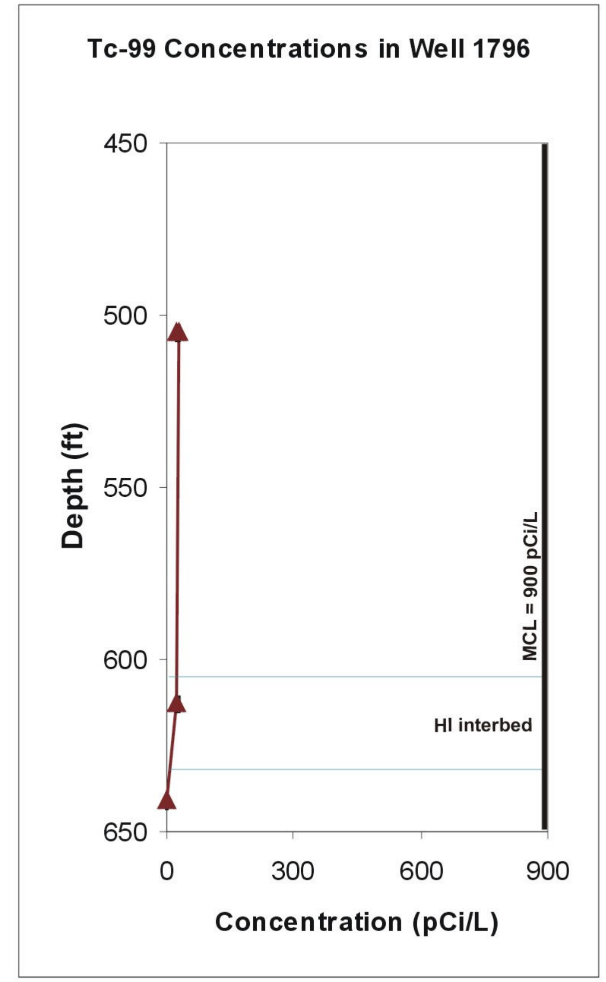
Depth (ft)	Result (pCi/L)	Flag
560	11100+/-317	
590	7170+/-261	
620	6370+/-254	

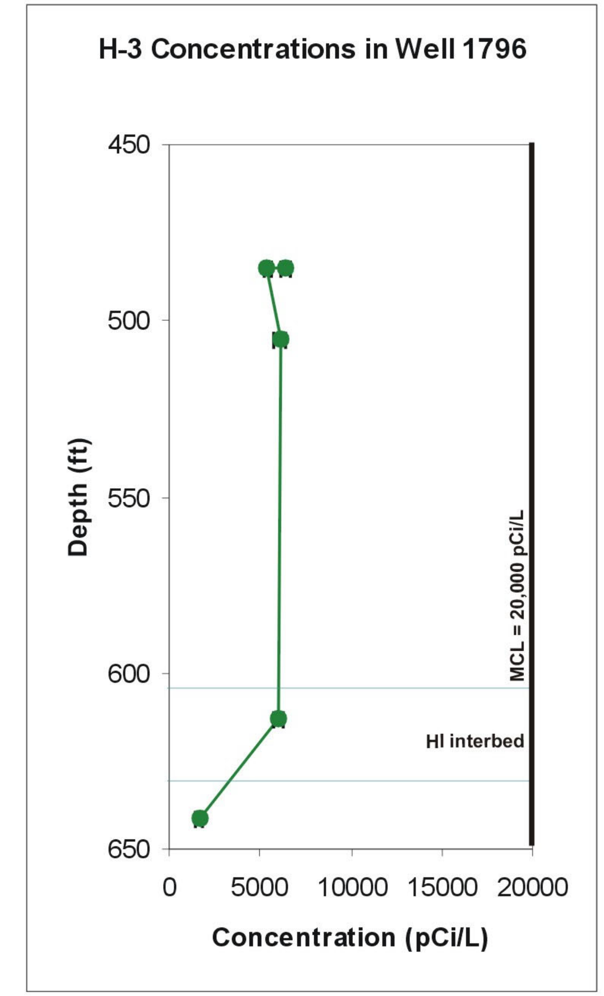
*Error bars represent +/- 1standard deviation.

Figure 3-5. Contaminant profile charts for boring ICPP-1795.









LL I-129 Concentrations in Well 1796

Depth (ft)	Result (pCi/L)	Flag
505	0.58+/-0.10	
505	0.66+/-0.08	
613	0.56+/-0.05	
641	0.04+/-0.01	UJ

Sr-90 Concentrations in Well 1796

Depth (ft)	Result (pCi/L)	Flag
485	8.33+/-1.06	
485	8.86+/-1.18	
505	7.94+/-1.05	
613	3.74+/-0.56	
641	0.20+/-0.21	U

Tc-99 Concentrations in Well 1796

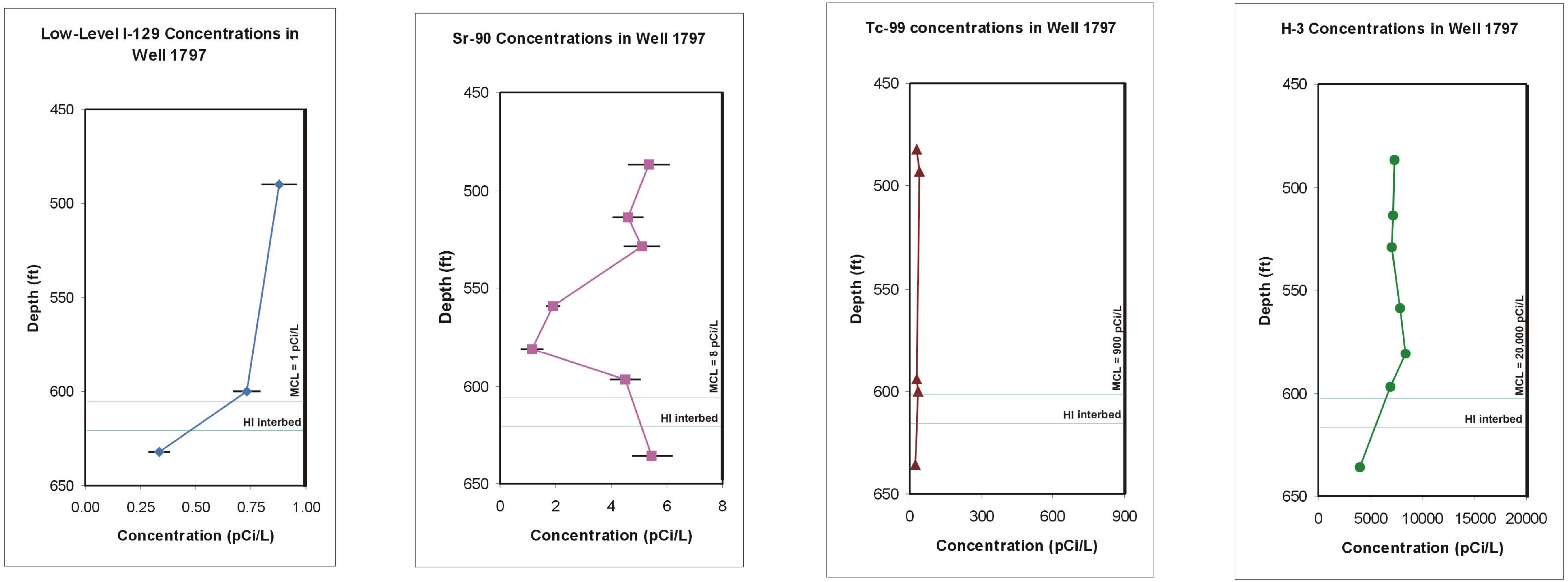
Depth (ft)	Result (pCi/L)	Flag
505	25.5+/-1.6	
505	27.0+/-1.6	
613	25.4+/-2.0	
613	25.0+/-2.3	
641	(-2.85+/-1.8)	U
641	(-4.22+/-2.2)	U

H-3 Concentrations in Well 1796

Depth (ft)	Result (pCi/L)	Flag
485	6380+/-253	
485	5400+/-218	
505	6080+/-279	
613	5970+/-275	
641	1690+/-190	

*Error bars represent +/- 1standard deviation.
*Results in parentheses are represented on the graph as having a value of zero.

Figure 3-6. Contaminant profile charts for boring ICPP-1796.



LL I-129 Concentrations in Well 1797

Depth (ft)	Result (pCi/L)	Flag
472-503	0.88+/-0.08	J
589-605	0.73+/-0.06	J
632	0.33+/-0.05	J

Sr-90 Concentrations in Well 1797

Depth (ft)	Result (pCi/L)	Flag
472-503	5.35+/-0.77	
506-521	4.61+/-0.56	
522-537	5.09+/-0.65	
551-567	1.90+/-0.27	
578-593	1.15+/-0.40	UJ
589-605	4.48+/-0.55	
636	5.46+/-0.72	

Tc-99 Concentrations in Well 1797

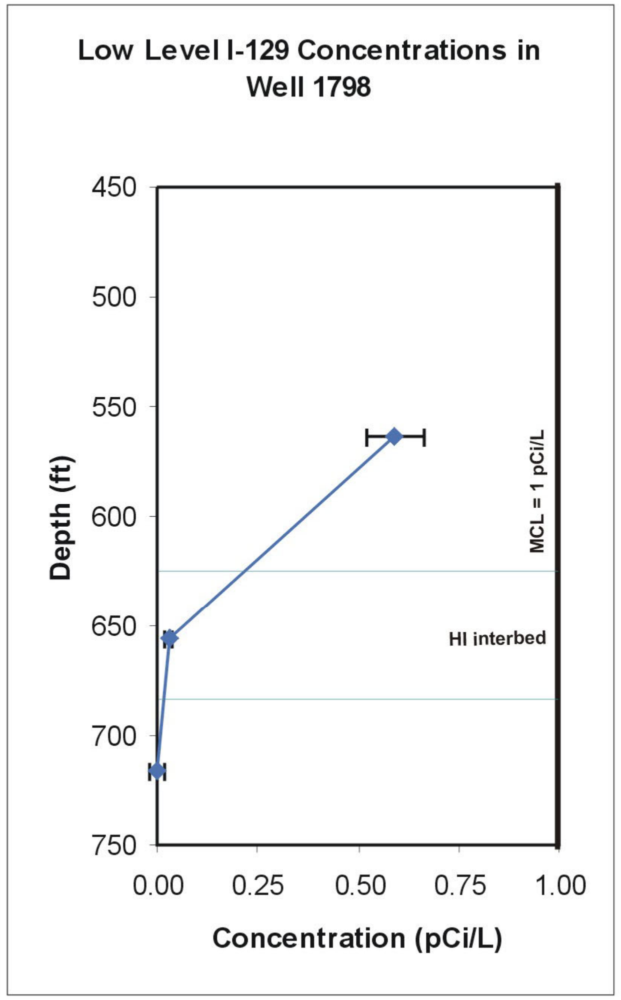
Depth (ft)	Result (pCi/L)	Flag
472-503	28.7+/-2.24	
472-503	39.4+/-2.91	
589-605	30.9+/-2.76	
589-605	33.2+/-2.89	
636	22.8+/-2.83	
636	22.1+/-2.89	

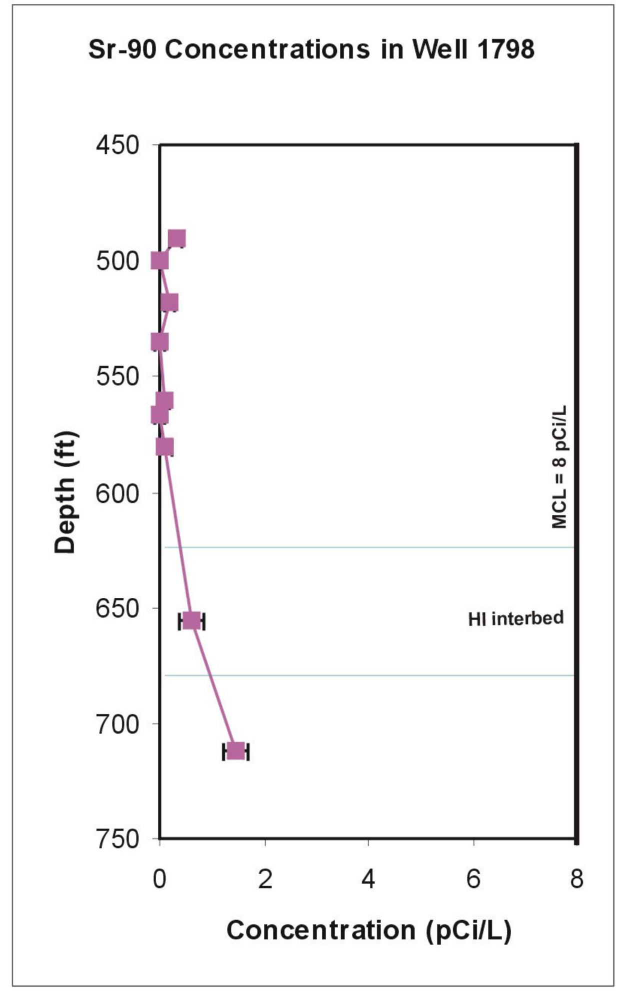
H-3 Concentrations in Well 1797

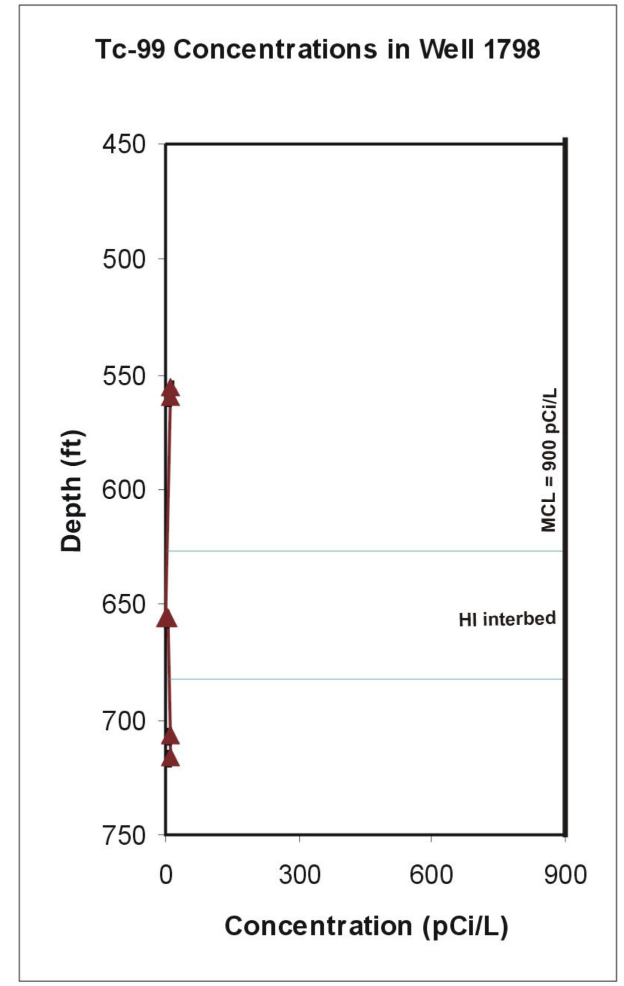
Depth (ft)	Result (pCi/L)	Flag
472-503	7330+/-273	
506-521	7150+/-270	
522-537	7000+/-268	
551-567	7840+/-281	
578-593	8400+/-291	
589-605	6930+/-266	
636	4010+/-142	

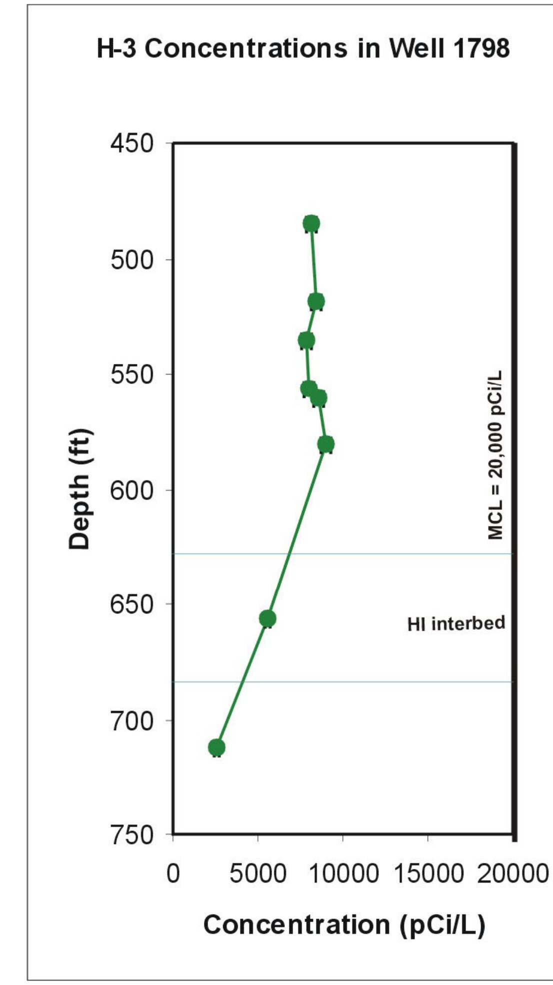
*Error bars represent +/- 1standard deviation.

Figure 3-7. Contaminant profile charts for boring ICPP-1797.









LL I-129 Concentrations in Well 1798

Depth (ft)	Result (pCi/L)	Flag
552-567	0.59+/-0.07	J
656	0.03+/-0.01	UJ
699-724	(-0.003+/-0.02)	U

Sr-90 Concentrations in Well 1798

Depth (ft)	Result (pCi/L)	Flag
480-507	0.31+/-0.12	UJ
480-507	0.00+/-.11	U
511-525	0.18+/-0.10	U
528-542	(-0.067+/-0.11)	U
552-567	0.08+/-0.12	U
552-567	(-0.01+/-0.08)	U
573-588	0.12+/-0.10	U
656	0.62+/-0.24	UJ
699-724	1.45+/-0.24	J

Tc-99 Concentrations in Well 1798

Depth (ft)	Result (pCi/L)	Flag
552-567	12.5+/-2.1	
552-567	9.82+/-2.13	
656	0.49+/-2.47	U
656	4.12+/-2.58	U
699-724	9.38+/-2.69	
699-724	9.72+/-2.79	

H-3 Concentrations in Well 1798

Depth (ft)	Result (pCi/L)	Flag
480-507	8080+/-289	
511-525	8460+/-292	
528-542	7820+/-283	
552-567	7970+/-287	
552-567	8600+/-296	
573-588	8960+/-304	
656	5590+/-159	
699-724	2620+/-122	

*Error bars represent +/- 1standard deviation.
*Results in parentheses are represented on the graph as having a value of zero.

Figure 3-8. Contaminant profile charts for boring ICPP-1798.

3.2.6.1 Iodine-129. In general, two groundwater samples were collected at each depth for I-129 analysis. One sample was analyzed for I-129 using a method that has an MDA (detection limit) of approximately 1 pCi/L (high-level I-129). The high-level I-129 analyses were performed in case higher I-129 activities (>10 pCi/L) were encountered in groundwater from the HI interbed, as had been predicted by the computer model. Another sample was analyzed using a low-level I-129 analytical method with an MDA of approximately 0.1 pCi/L. The low-level I-129 proved the most useful. All I-129 activities in groundwater were below the 1-pCi/L MCL and the highest reported I-129 activity was 0.88 ±0.08 pCi/L (472-503-ft depth in ICPP-1797). Note that all of the high-level sample results were assigned U or UJ flags, indicating that I-129 was not present above the MDA of approximately 1.0 pCi/L.

3.2.6.2 Strontium-90. The Sr-90 activities were below the 8-pCi/L MCL in all samples except for two samples taken from ICPP-1796 at 485 ft below ground surface (above the HI interbed). The Sr-90 activities in groundwater at this depth were 8.33 ±1.06 pCi/L and 8.86 ±1.18 pCi/L, which are slightly over the 8-pCi/L MCL. With respect to Boreholes ICPP-1795 and ICPP-1798, the highest Sr-90 activities were observed below the HI interbed.

3.2.6.3 Tritium. Tritium activities in groundwater were below the MCL (20,000 pCi/L) at every depth and sample location. The highest tritium activity observed was 11,100 ±317 pCi/L at 560 ft below ground surface (above the HI interbed) in Borehole ICPP-1795.

3.2.6.4 Tc-99 Duplicate Sample Results. Groundwater samples were collected for Tc-99 analysis above, within, and below the HI interbed. All Tc-99 activities were below the 900-pCi/L MCL, with the highest activity reported as 39.4 ±2.91 pCi/L in ICPP-1797 (472–503 ft below ground surface).

As described in the Plume Evaluation Field Sampling Plan (DOE-ID 2002a), the Tc-99 results were used to determine the need to perform more costly duplicate I-129 analyses. A single Tc-99 sample was collected when sampling began at a specific depth and another duplicate sample was collected at the end of the sampling period at that depth. An additional low-level I-129 sample also was collected and archived from the sample depth interval. Then, the sample results from the two Tc-99 samples were statistically compared to determine the variability associated with the sample collection process. This was done by computing the mean difference of the duplicate results by the following procedure shown in Equation (1) below, as specified in the Plume Evaluation Field Sampling Plan (DOE-ID 2002a):

$$MD = \frac{|S - D|}{\sqrt{\left(\sigma_s^2 + \sigma_D^2\right)}} \tag{1}$$

where

MD	=	the mean difference (MD) of the duplicate results
S	=	the original sample result (as pCi/g or pCi/L)
D	=	the duplicate sample result (as pCi/g or pCi/L)
σs	=	the associated total propagated 1σ uncertainty of the original result (as standard deviation)
σD	=	the associated total propagated 1σ uncertainty of the duplicate result (as a standard deviation).

An MD value of approximately 3 indicates that the results agree (overlap) at the 3σ confidence interval. An MD value of 1 indicates that the results agree at the 1σ confidence interval. If the MD >3, the relative percent difference (RPD) would be calculated, and if the result was less than 20%, then the samples were considered to be in agreement.

For each pair of duplicates, the duplicate results agreed with one another at the 3σ confidence interval, indicating that all results were representative and replicable. Because the duplicate Tc-99 results were statistically identical, duplicate I-129 laboratory analyses were not performed, as specified in the Plume Evaluation Field Sampling Plan (DOE-ID 2002a). Table 3-8 summarizes the results of these calculations.

Table 3-8. The Tc-99 duplicate sample results.

Well	Depth (ft)	Tc-99 Result 1 (pCi/L)	Sample Error (pCi/L)	Tc-99 Result 2 (pCi/L)	Sample Error (pCi/L)	Mean Differencea	Relative Percent Differenceb
1795	560	6.95	1.44	6.92	1.55	0.01	0.43
1795	590	14.1	1.9	13.7	1.93	0.15	2.88
1795	620	17.7	1.7	13.4	1.58	1.85	27.65
1796	505	27	1.61	25.5	1.6	0.66	5.71
1796	613	25.4	2.01	25	2.26	0.13	1.59
1796	641	-2.85 U	1.82	-4.22 U	2.20	NA	NA
1797	472–503	28.7	2.24	39.4	2.91	2.91	31.42
1797	589–605	30.9	2.76	33.2	2.89	0.58	7.18
1797	636	22.8	2.83	22.1	2.89	0.17	3.12
1798	552–567	12.5	2.07	9.82	2.13	0.90	24.01
1798	656	0.49 U	2.47	4.12 U	2.58	NA	NA
1798	699–724	9.38	2.69	9.72	2.79	0.09	3.56

a. If MD <3, results for duplicates are considered statistically identical.

b. If MD >3 and RPD <20, results for duplicates are considered statistically identical.

MD = mean difference
NA = not applicable
RPD = relative percent difference
U = undetected (data qualifier flag)

4. REVISED I-129 SOURCE TERM

Several lines of evidence suggest that the injection well I-129 source term assumed in the 1997 RI/BRA groundwater modeling was too high. First, the total I-129 estimated to be present within the groundwater plume is far less than the 1.39 Ci total I-129 that the RI/BRA assumed to have been discharged to the injection well (Beasley, Dixon, and Mann 1998). Second, it appears that the period for which I-129 discharge data are available (1976 to present) includes a time period during 1978–79 when I-129 releases to service waste were higher than normal. The post-1976 I-129 data were averaged during the RI/BRA to obtain an estimate of the monthly I-129 discharge to the injection well. Because the I-129 pulse that occurred in 1978–79 was included in the calculations, a higher monthly average was obtained than if this period had been excluded. And finally, process knowledge indicates that before startup of the Waste Calcining Facility (WCF) in 1963, most of the I-129 released during spent fuel processing would have accumulated in the high-level liquid waste stored at the tank farm, rather than be discharged to the injection well. Therefore, another evaluation of I-129 discharges to the injection well is warranted. The approach to this problem, along with detailed calculations and the results of a revised injection well I-129 source assessment, are presented in Engineering Design File (EDF) -3943 (Appendix D to this document). A brief summary of the revised I-129 source term estimate is presented below.

As a fission product, the I-129 present at INTEC is attributable to activities associated with the management of spent nuclear fuel. Essentially all of the I-129 was present within the spent fuel brought to INTEC for processing; virtually no I-129 was produced at INTEC. Therefore, it is possible to calculate the approximate total I-129 inventory that has been present at INTEC based on the total quantity of spent fuel reprocessed. Cordes (1978) performed such an analysis using the "fissions processed" approach, along with the I-129 fission yield. Using this approach, Cordes estimated that a total of approximately 5 Ci of I-129 was present in the fuel processed from 1953 to 1977. Virtually all of this total would have been released to the first-cycle raffinate during spent fuel dissolution. Following its liberation from the spent fuel, the I-129 would have ended up at one of the following four destinations: (1) temporary storage in tank farm liquid waste, (2) atmospheric discharge from the main stack, (3) groundwater discharge of process equipment waste to the injection well, and (4) storage in solid calcine material in WCF bins. McManus et al. (1982) performed a detailed study of I-129 fate at INTEC and determined that the vast majority of the I-129 was discharged to the atmosphere through the main stack. A much lesser quantity of I-129 went to the injection well, and only a negligible quantity would have ended up in the solid waste (calcine).

McManus et al. (1982) also investigated the relationship between the plant processes and I-129 activity in service waste. Among other findings, their study demonstrated that I-129 releases from INTEC were related primarily to (1) WCF operation and (2) high-level waste evaporator (HLWE) operation. When the WCF was operating, overall I-129 discharges to both the atmosphere (via the main stack) and to service waste were higher. When the HLWE was operating, I-129 activities in service waste increased by approximately a factor of 10, as compared to periods when the HLWE was not operating.

Historical information on WCF and HLWE operational periods and the correlation between operational status of these two facilities and I-129 activities in service waste are included in EDF-3943 (Appendix D of this document). Using this information, the total I-129 activity discharged to the former injection well during its lifetime was recalculated. These calculations are based on historical records of the operational status of the WCF (or New Waste Calcining Facility) and the HLWE, coupled with the observed I-129 activities in the service waste during periods when the WCF and/or HLWE were operating (or not). These calculations indicate that a maximum of 0.86 Ci I-129 was discharged to groundwater through the former injection well during its lifetime. This value is approximately 62% of the previous estimate of 1.39 Ci I-129 used in the RI/BRA modeling. While the new estimate still appears too large based on the amount of I-129 present in the aquifer, it nevertheless appears to be more realistic than the

RI/BRA total I-129 value. Refer to EDF-3943 for details on the I-129 calculations and assumptions, along with additional supporting information regarding the factors affecting the disposition of I-129 at INTEC during spent fuel reprocessing.

5. COMPARISON OF SIMULATED AND OBSERVED AQUIFER CONDITIONS NEAR THE INTEC

Modeling the SRPA for the Waste Area Group 3 Operable Unit 3-13 RI/BRA (DOE-ID 1997) predicted a risk beyond the year 2095 to groundwater users. High concentrations of I-129 were predicted to remain in the low-hydraulic-conductivity HI sedimentary interbed. However, the OU 3-13 RI/BRA modeling was performed using only a limited amount of empirical data for parameterizing the HI interbed; no empirical data were available for verifying the presence or absence of contaminants in the interbed.

The OU 3-13 RI/BRA aquifer model was updated during OU 3-13, Group 5 remedial actions (DOE-ID 2002b). The aquifer model update included rediscretization and re-parameterization to more accurately simulate the HI interbed and deep aquifer. Field and laboratory testing performed for this report provided vertical profiling of I-129, Sr-90, Tc-99, tritium concentrations, and geotechnical data across the HI interbed at four borings downgradient of the INTEC. These data were used to adjust the current model’s interbed parameterization and contaminant source terms to be consistent with the latest observations. Furthermore, the I-129 source term was revised by analysis of historical INTEC processes. A complete description of the current WAG 3 aquifer numerical model is provided in Appendix B. Only the model's purpose, description, and simulation results are summarized in this section.

5.1 Model Purpose

The RGs of OU 3-13, Group 5 are to monitor groundwater concentrations and perform treatability studies if groundwater concentrations exceed the specified action level. The numerical model will be used to assess the effectiveness of different remedial scenarios, assess future concentrations from current observations, or adjust the action level.

Updating the Group 5 aquifer model will coincide with updating the Group 4 aquifer model and developing the OU 3-14 aquifer model. The contaminated perched water addressed by the Group 4 RGs does not pose a risk to human health because it is not available for consumption. However, the perched water does pose a risk as a contaminant transport pathway to the SRPA. The Group 4 aquifer model along with an updated vadose model will be used to assess the effectiveness restricting various surface water recharge sources to minimize transport of contaminated perched water to the aquifer.

The purpose of the OU 3-14 aquifer model will be to calculate future risks from COCs identified in the OU 3-14 RI/FS and evaluation of proposed remedial actions. The following summarizes the primary anticipated uses of the OU 3-14 simulation results: (1) Baseline tank farm risk evaluation from the groundwater pathway. Aquifer concentrations will be predicted and used for the risk assessment. (2) Baseline cumulative risk evaluation. The cumulative risk from all the INTEC sources including OU 3-14 sources, OU 3-13 sources excluding tank farm source, and INEEL CERCLA Disposal Facility sources. (3) Evaluation of proposed remedial actions. During the feasibility study phase of the OU 3-14 RI/FS, remedial action alternatives will be recommended and the model will be used to evaluate the effectiveness of these alternatives.

5.2 Model Description

The WAG 3 aquifer modeling was performed using the TETRAD multipurpose simulator software (Vinsome and Shook 1993). The aquifer model domain extends from approximately 2.5 km north of the INTEC facility to the southern INEEL boundary in the north-south direction and approximately 6.5 km east of the INTEC facility to approximately 1 km west of the Radioactive Waste Management Complex

(RWMC) facility in the east-west direction. The model was discretized (subdivided) into 400 × 400 grid blocks in the horizontal and used variable vertical discretization that followed the HI interbed.

The aquifer model used four distinct stratigraphic types. These include the E through H basalts, the upper I basalt, the HI interbed, and the lower I basalt. The upper I basalt was defined as the top 25 m of the aquifer where the I basalt flow is at or above the water table. This part of the I basalt flow was separated from the majority of the I basalt flow because it is at the water table and wells are completed in this area of the I basalt flow, providing a pump-test-based permeability field.

The Big Lost River flows across the aquifer model domain, and the long-term average infiltration from the Big Lost River was applied directly in the aquifer model outside the area of the OU 3-13 RI/BRA vadose zone model footprint. Infiltration within the footprint was accounted for indirectly through the water and contaminant flux boundary condition from the OU 3-13 RI/BRA vadose zone model. In addition to the Big Lost River, the pumping from the water supply wells (CPP-02, CPP-04, CFA-1, and CFA-2) and reinjection into the former injection well (CPP-03) were included in the simulations. The boundary conditions included the following: specified flux at the surface (including the water sources discussed above), no flux at the bottom, and specified heads on the sides.

5.3 Current Model Predictive Simulations

The contaminants with substantial aquifer plumes migrating from the INTEC were simulated with the current model. The simulated contaminants included the following: I-129, tritium, Tc-99, and Sr-90. Table 5-1 lists each contaminant, the half-life, the partition coefficients (Kd), the 10-6 risk concentration, and the federal drinking water standard (MCL). The partition coefficients of the contaminants that react with the subsurface (Sr-90 and Tc-99) were calibrated to better match the observed plumes. The Tc-99 and Sr-90 partition coefficient calibration is discussed in Sections 5.3.3 and 5.3.4, respectively. The simulations used the Waste Area Group 3 Operable Unit 3-13 RI/BRA vadose zone simulations as the upper water and contaminant boundary condition and contain all the uncertainties of the Operable Unit 3-13 RI/BRA vadose zone model. The tritium flux rate was adjusted to match vertical concentrations measured downgradient in the vertical profile boreholes. This upper boundary condition represents water flow from the vadose zone and contaminant flux from soil contamination, tank farm releases, and the CPP-3 injection well during the period it failed and discharged to the vadose zone.

The tritium flux rate needed to be adjusted because the current tritium concentrations in the aquifer near the INTEC are most likely the result of continuing contaminant sources from the INTEC vadose zone. Simulations of the INTEC large-scale tracer test performed in 2001 using the Operable Unit 3-13 RI/BRA vadose zone model[a] indicated that the effective interbeds conceptual model is inadequate for representing the actual system. If monitoring locations were located below the model's first sedimentary interbed, then the simulated tracer concentrations produced by the OU 3-13 model generally lagged behind field measurements. This was because the simulated interbeds may be laterally more extensive and have a lower permeability than the actual interbeds. In general, these results indicate that the actual tracer was able to move much faster in the vertical direction than the simulated tracer.

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a. EDF-3213, 2003, "Idaho Nuclear Technology and Engineering Center Large-Scale Tracer Test Simulation (Draft)," Idaho Completion Project, December 2003.

Table 5-1. Predictive simulation contaminant parameters.

Contaminant	Half-life (years)	Sediment Kd (ml/g)	Basalt Kd (ml/g)	Federal Drinking Water Standarda (pCi/L)
I-129	1.57e+7	0	0.	1
Tritium (H-3)	12.3	0	0.	20,000
Sr-90	29.1	6	0.1	8
Tc-99	2.11e+5	0.075	0.0013	900

a. Based on the National Interim Primary Drinking Water Regulations (EPA 1976).

Furthermore, geochemical analysis of perched water and disposal pond water (DOE-ID 2003b) indicated that the disposal pond water did not move as far laterally as the OU 3-13 RI/BRA model predicted. These discrepancies between the observed and the OU 3-13 RI/BRA vadose model simulated conditions indicate the RI/BRA boundary condition is an uncertain model input, which may need to be adjusted in the aquifer model update.

The injection well I-129 source was thought to be conservatively overestimated in the OU 3-13 RI/BRA modeling and was reevaluated in the current modeling.

The current model's predictive simulations are discussed in Sections 5.3.1 through 5.3.4.

5.3.1 Iodine-129

The OU 3-13 RI/BRA I-129 source consisted of 1.52 Ci and was divided between 91.6% injection well, 5% percolation ponds, and 3% other sources. The I-129 discharge data to the CPP-3 injection well were only reported from 1976 through 1985 and the RI/BRA model's injection well I-129 source was extrapolated before 1976. The RI/BRA I-129 source overpredicted current concentrations observed in the aquifer.

The injection well source was reduced from 1.39 Ci to 0.86 Ci, based on analysis of the historical INTEC processes and the need to better match current aquifer concentrations. A full explanation of the revised I-129 source term is presented in Section 4 and Appendix D.

Perched water concentrations that may be the result of the injection well collapse and subsequent discharge to the vadose zone also may suggest that the early RI/BRA I-129 source may have been overestimated. The average I-129 concentration using the RI/BRA source was approximately 30 pCi/L during the reported period. This value was calculated from the average disposal rate of 1.2 × 108 pCi/day in 4,000 m3/day of injection water (DOE-ID 1997). The deep-perched water near the injection well should be near this concentration, if significant water is not moving through the perched water and the RI/BRA I-129 source is accurate. However, sampling of the nearest deep-perched water sampling location (USGS-50) to the CPP-3 injection well detected I-129 at 0.65 pCi/L (DOE-ID 2003b), suggesting that the I-129 source strength might have been significantly overestimated or there is a significant flux of clean water moving through the perched water.

The I-129 concentrations simulated by current model with the new source term exceeded the MCL through the year 2060. The simulated 2001 peak I-129 concentration was 3.0 pCi/L and was located approximately 400 m west of the Central Facilities Area (CFA). The peak measured I-129 concentration during 2001 sampling was 1.06 pCi/L in Well LF3-08, which is located approximately 1,000 m northwest of the CFA. The simulated 2095 peak I-129 concentration was 0.5 pCi/L and was located south of the INTEC near the southern INEEL boundary. The much-higher-simulated-than-observed I-129 concentrations in 2001 suggest the revised source term discussed in Section 4 may still be overestimating the I-129 source. Figures 5-1 through 5-4 illustrate simulated I-129 peak aquifer concentrations, horizontal concentrations in 2001, vertical concentrations in 2003, and a comparison of simulated and observed concentrations in the vertical profile boreholes in 2003, respectively. The observed I-129 concentrations from 2001 sampling are illustrated in Figure 5-5. Simulated horizontal concentrations are presented for 2001, because the last round of complete aquifer sampling was performed in 2001 and these observations provided the best data set for model comparison.

The CFA-1 and CFA-2 production wells historically have produced approximately 250,000 gal/day and the wells were included in the aquifer simulations. The total I-129 produced from these two water-supply wells for the period 1954 through 2003 was only 0.01 Ci. This value is only a small fraction of the total I-129 injection well inventory, because the I-129 plume is very dilute at the production well locations. The model indicates the wells do not capture a significant portion of the I-129 plume.

It appears that the current I-129 contamination in the aquifer near INTEC primarily is derived from I-129 discharged in the former percolation ponds and I-129 that entered the vadose zone during the injection well collapse that is slowly migrating to the aquifer. The I-129 resulting from the injection well should have moved far south of the INTEC facility by this time, because of the fast aquifer velocity (approximately 2 m/day) and the fact that regular injection well operation ceased in 1984. However, very low permeability and localized basalt formations near INTEC could be slowly releasing I- 129 under the natural gradient. The groundwater mound resulting from the injection well operation most likely produced an artificial gradient, which may have moved contaminants in the lower permeability basalt relatively quickly compared to their release under the natural gradient. Approximately 7% of the total I-129 source was discharged to the vadose zone via the percolation ponds and the injection well during the well collapse period. The I-129 concentrations should decrease in the future as the vadose zone sources are depleted. The conclusions regarding current I-129 contamination in the aquifer near the INTEC are based on the conceptual and numerical modeling assumptions presented in this report.

Simulated I-129 concentrations were higher than those observed. Groundwater monitoring results for 2003 show I-129 concentrations below the MCL at all locations. The difference between simulated and measured I-129 concentrations may be due to overestimation of the I-129 source term or some unknown attenuation mechanism such as adsorption, which is not considered in the current conceptual and numerical model.

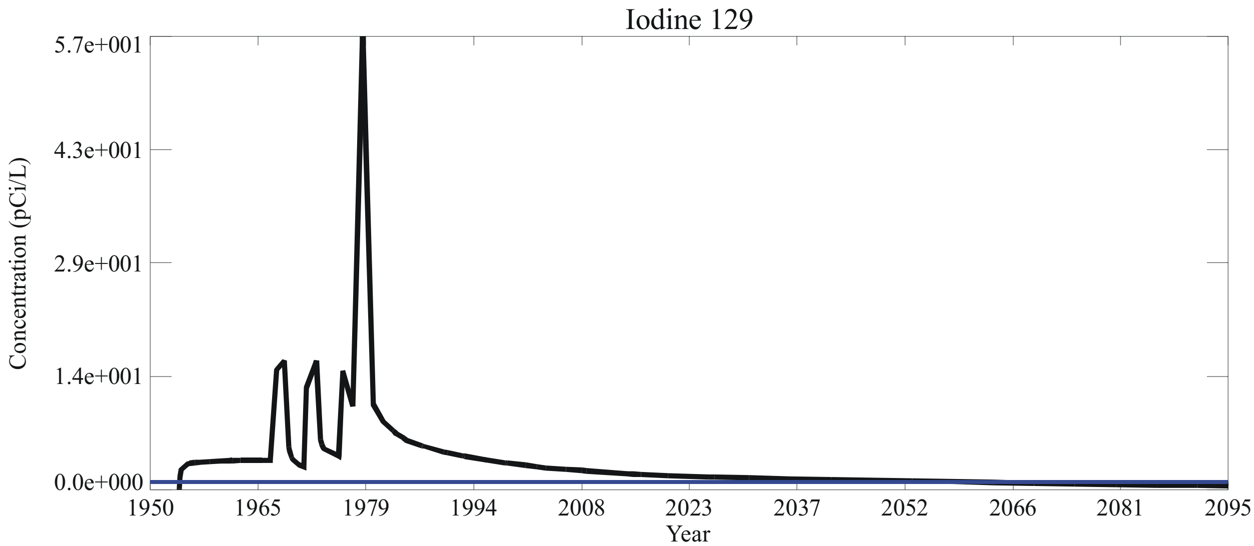

Figure 5-1. Simulated I-129 peak aquifer concentrations (blue line is the MCL).

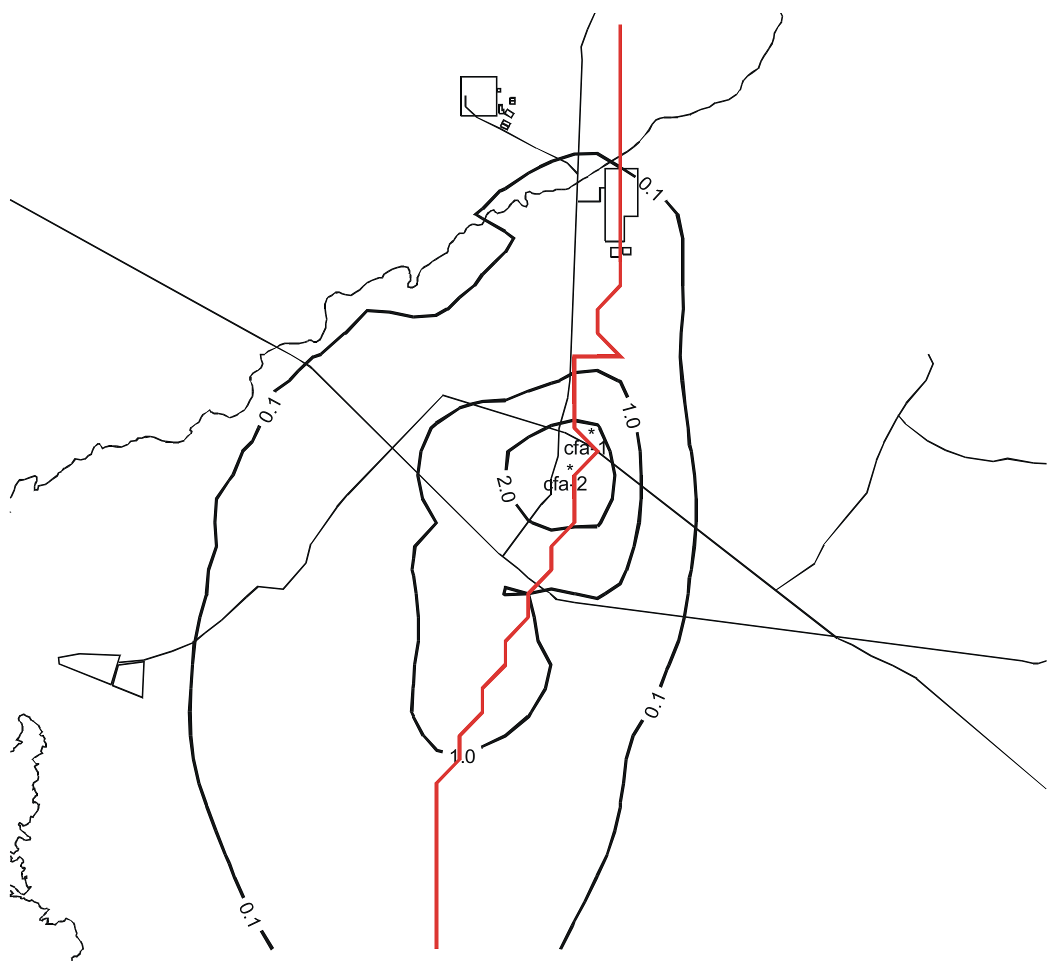

Figure 5-2. Simulated I-129 (pCi/L) concentrations at the water table in 2001 (the thick red line is a fence diagram cross-section for Figure 5-3).

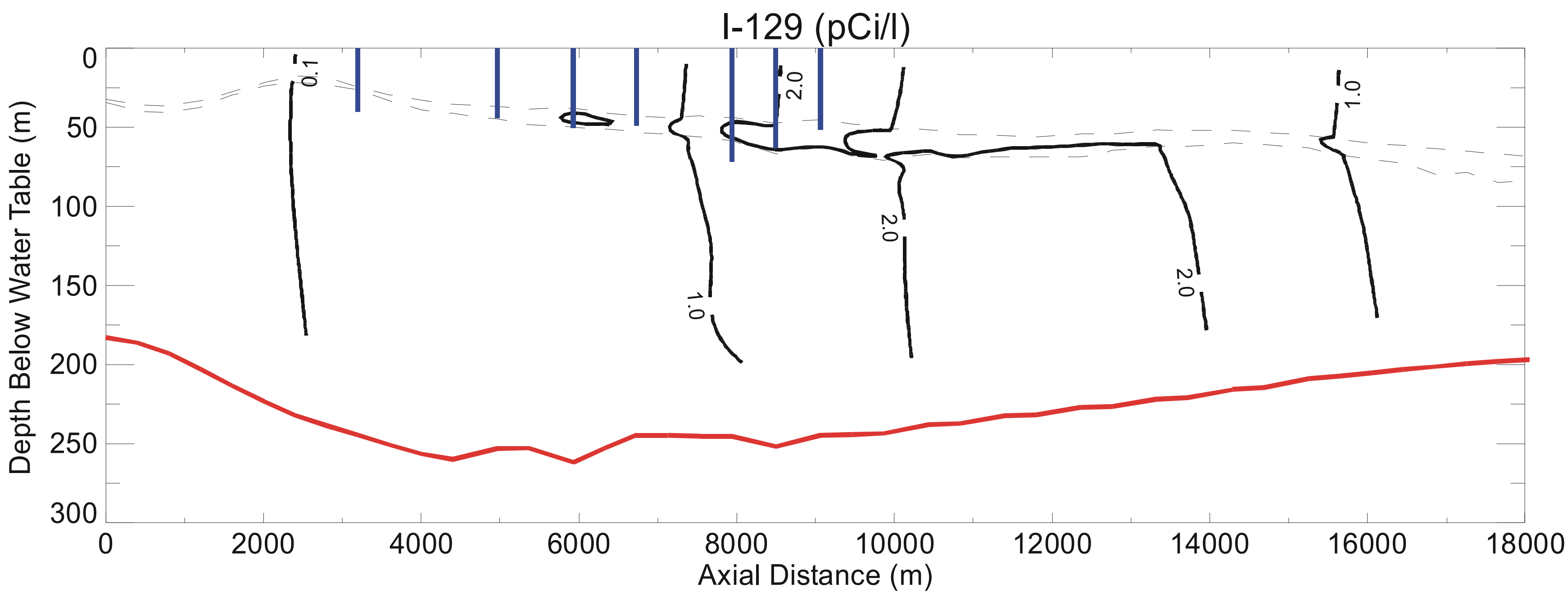

Figure 5-3. Simulated I-129 vertical concentrations in 2003 (the blue lines are well locations and red line is aquifer bottom).

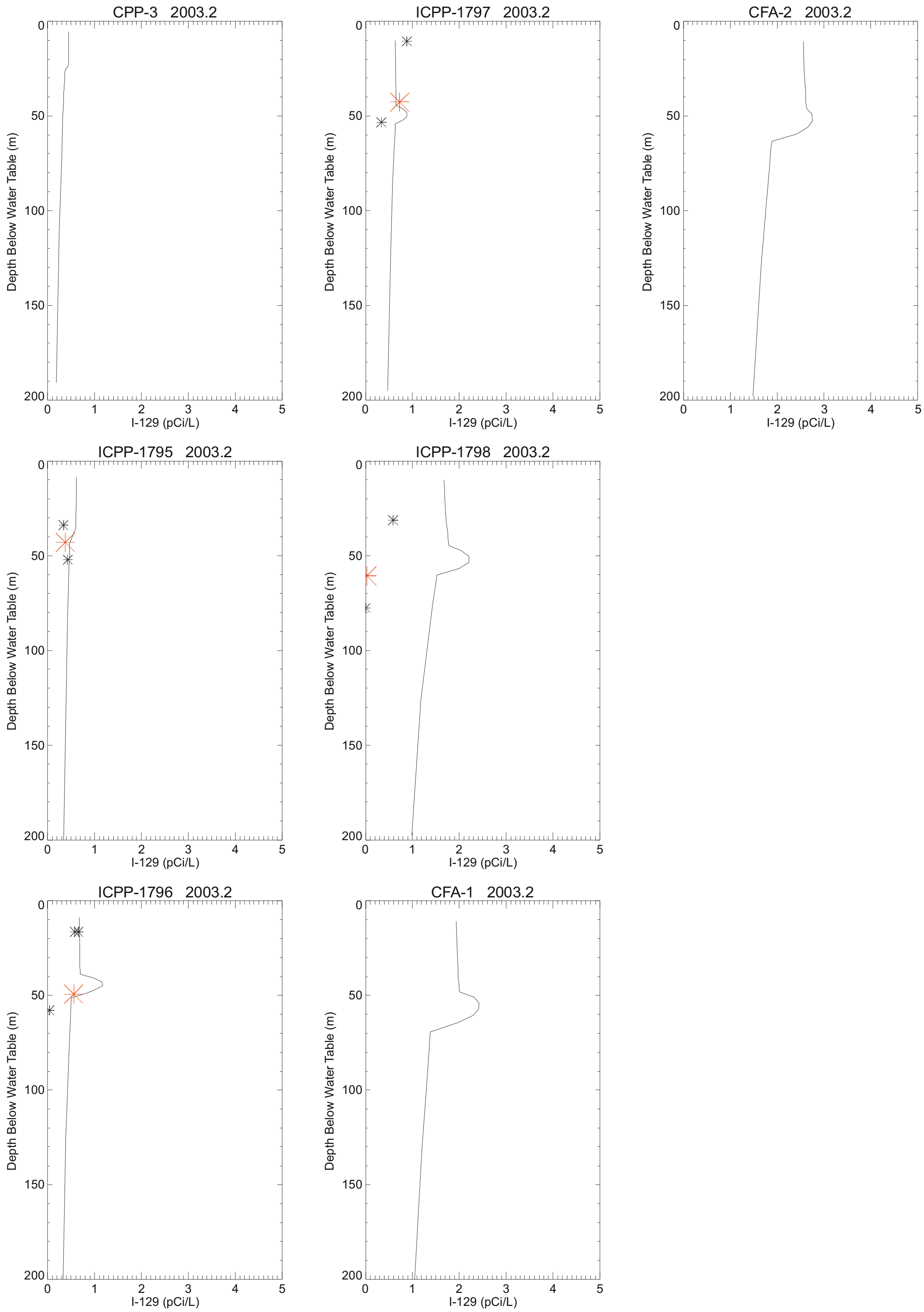

Figure 5-4. Simulated I-129 versus measured concentrations at vertical boreholes in 2003 (the solid line is simulated, the small asterisk is measured basalt, and the large asterisk is measured HI interbed).

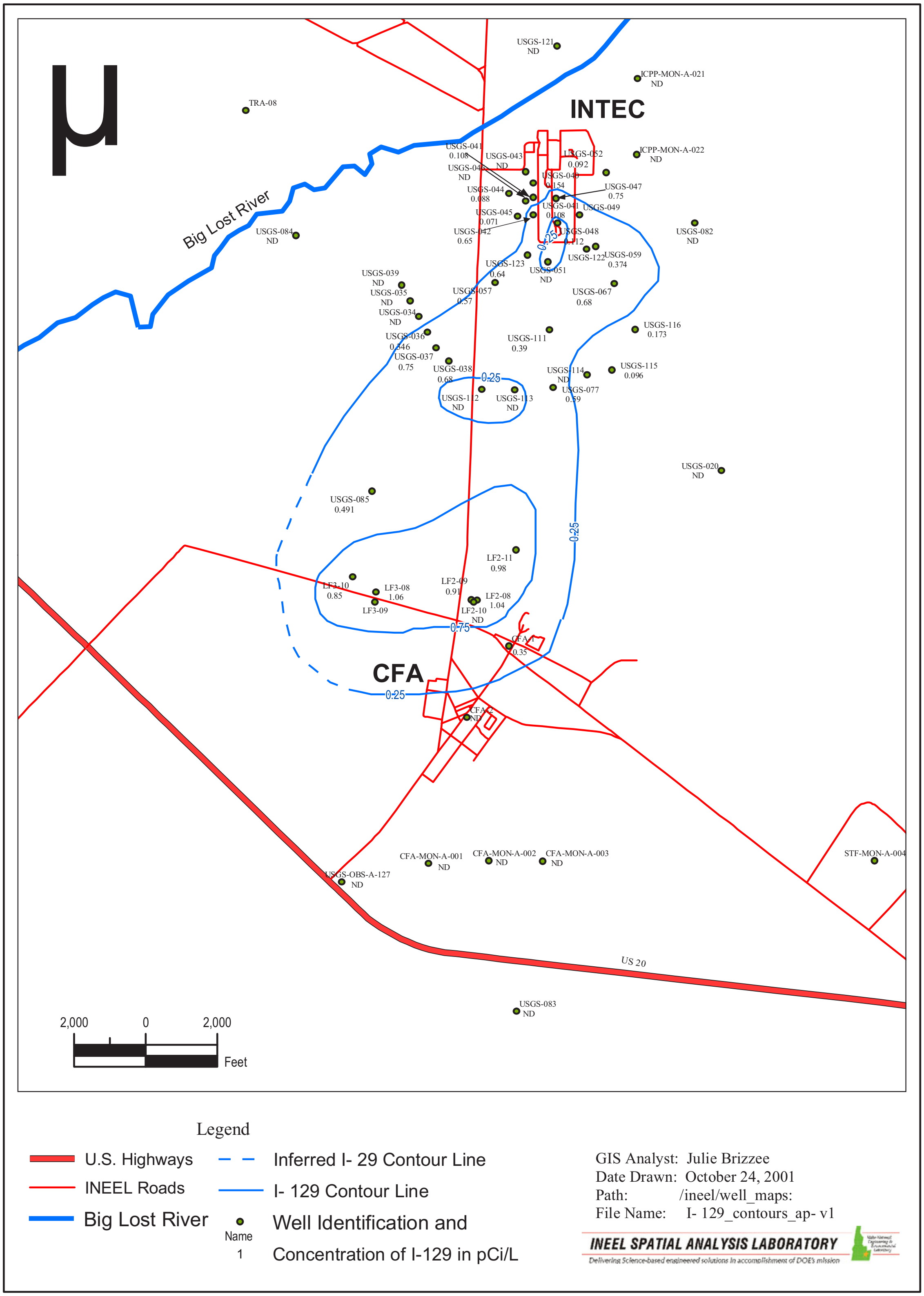

Figure 5-5. Observed I-129 aquifer concentrations in 2001.

5.3.2 Tritium

The Operable Unit 3-13 RI/BRA tritium source consisted of 30,400 Ci of which 71% is from the INTEC area and 29% is from the Test Reactor Area (TRA). The 71% from the INTEC area is 66% injection well, 3% percolation ponds, and 2% other sources. The current model's vadose zone tritium flux was increased by a factor of 2.5 to match observed concentrations in the vertical profile boreholes. The increase represents 1,305 Ci out of 21,495 Ci total tritium released into the lithosphere from INTEC operations or 1,305 Ci out of 2,104 Ci total tritium released to the INTEC vadose zone. The increased vadose zone flux increase did not increase the total vadose zone tritium sources to the aquifer beyond 2,104 Ci during the 1954 through 2003 simulation period.

Simulated tritium concentrations exceeded the MCL through the year 1999. The simulated 2001 peak tritium concentration that was not associated with the TRA tritium plume was 13,905 pCi/L and was located 400 m south of the former percolation ponds. The peak tritium concentration measured during 2001 sampling was 14,000 pCi/L in Well USGS-114, which is located approximately 900 m south of the former percolation ponds. The tritium simulation was not performed beyond 2003 because of uncertainty in the vadose zone flux boundary condition, which needs to be better understood for predictive modeling. Figures 5-6 through 5-9 illustrate simulated tritium peak aquifer concentration, horizontal concentrations in 2001 at the water table, vertical concentrations in 2003, and simulated with observed in the vertical profile boreholes in 2003, respectively. The observed tritium concentrations from 2001 sampling are illustrated in Figure 5-10.

The simulated and observed tritium plumes are different, because the observed plume was estimated without using TRA tritium data and assuming the current plume is disconnected from the historical plume south of the CFA. Tritium concentrations south of the CFA in Wells USGS-104 and USGS-106 were approximately 1,000 pCi/L in 2003. These observations are still less than model predictions, but indicate that tritium originating from the INTEC is still observable south of the CFA.

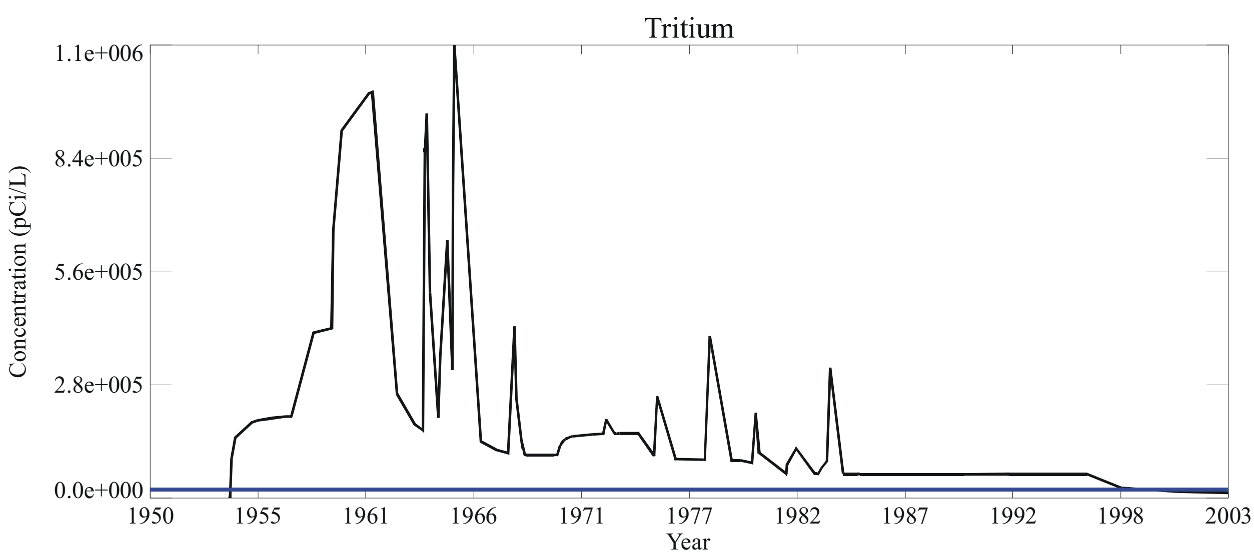

Figure 5-6. Simulated tritium (pCi/L) peak aquifer concentrations (blue line is the MCL).

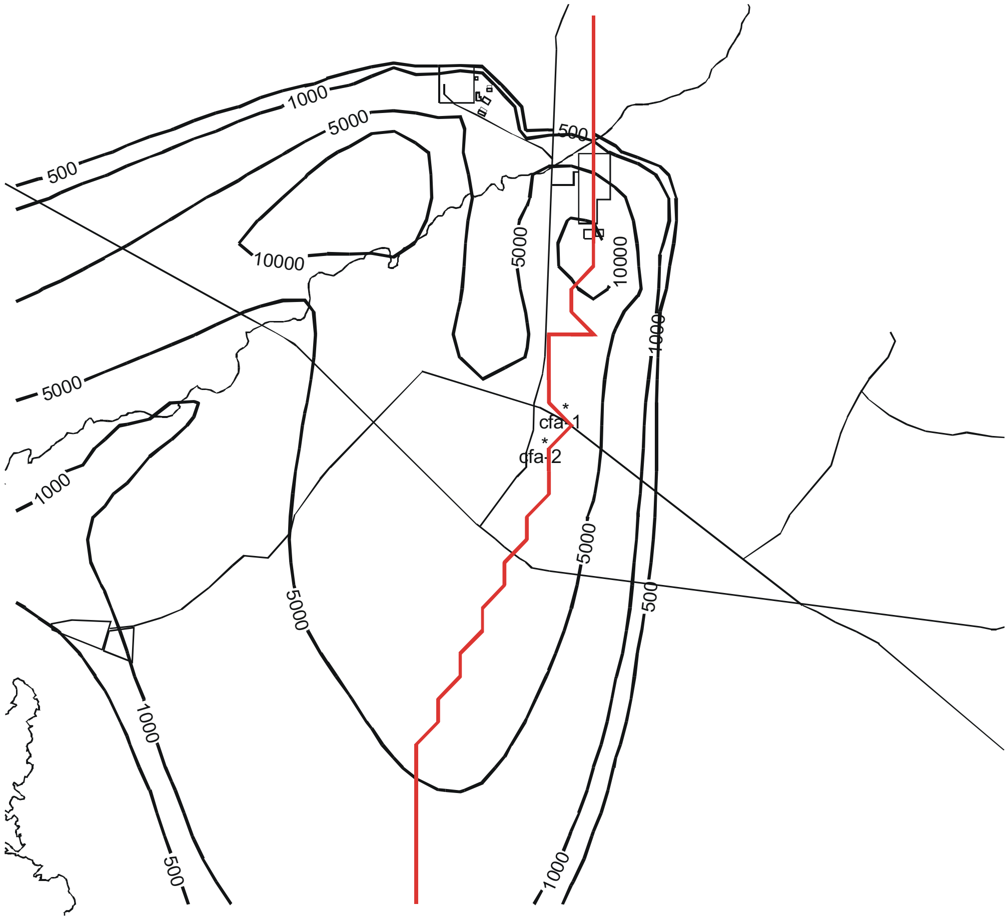

Figure 5-7. Simulated tritium (pCi/L) concentrations at the water table in 2001 (the thick red line is a fence diagram cross-section for Figure 5-8).

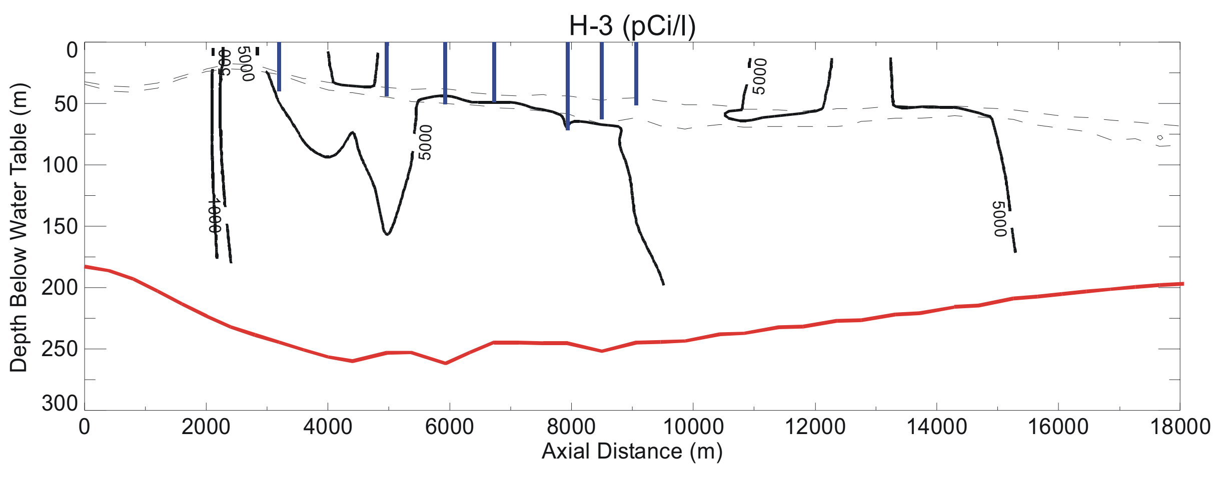

Figure 5-8. Simulated tritium vertical concentrations in 2003 (the blue lines are well locations and red line is aquifer bottom).

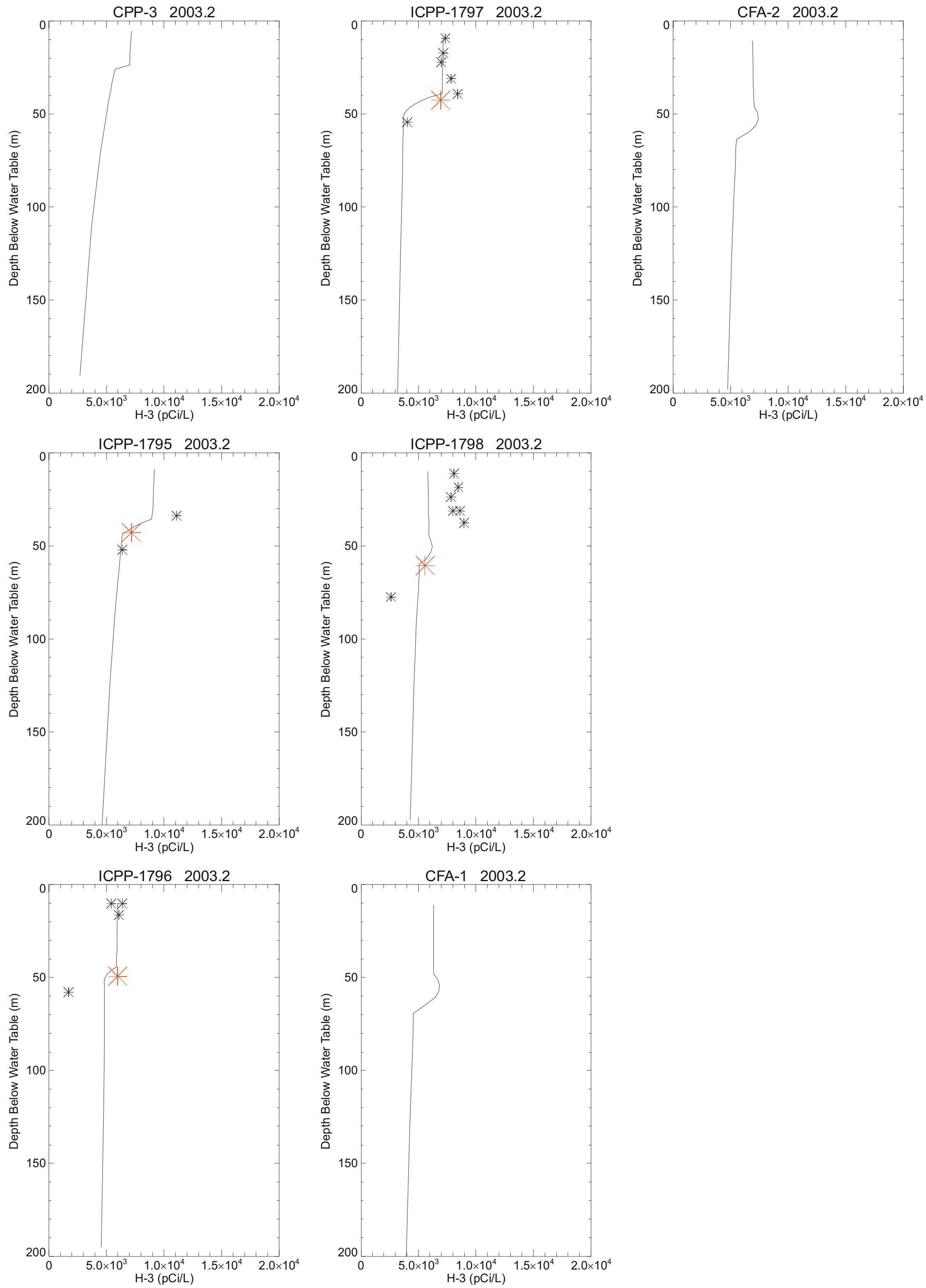

Figure 5-9. Simulated tritium versus measured concentrations at vertical boreholes in 2003 (the solid line is simulated, the small asterisk is measured basalt, and the large asterisk is measured HI interbed).

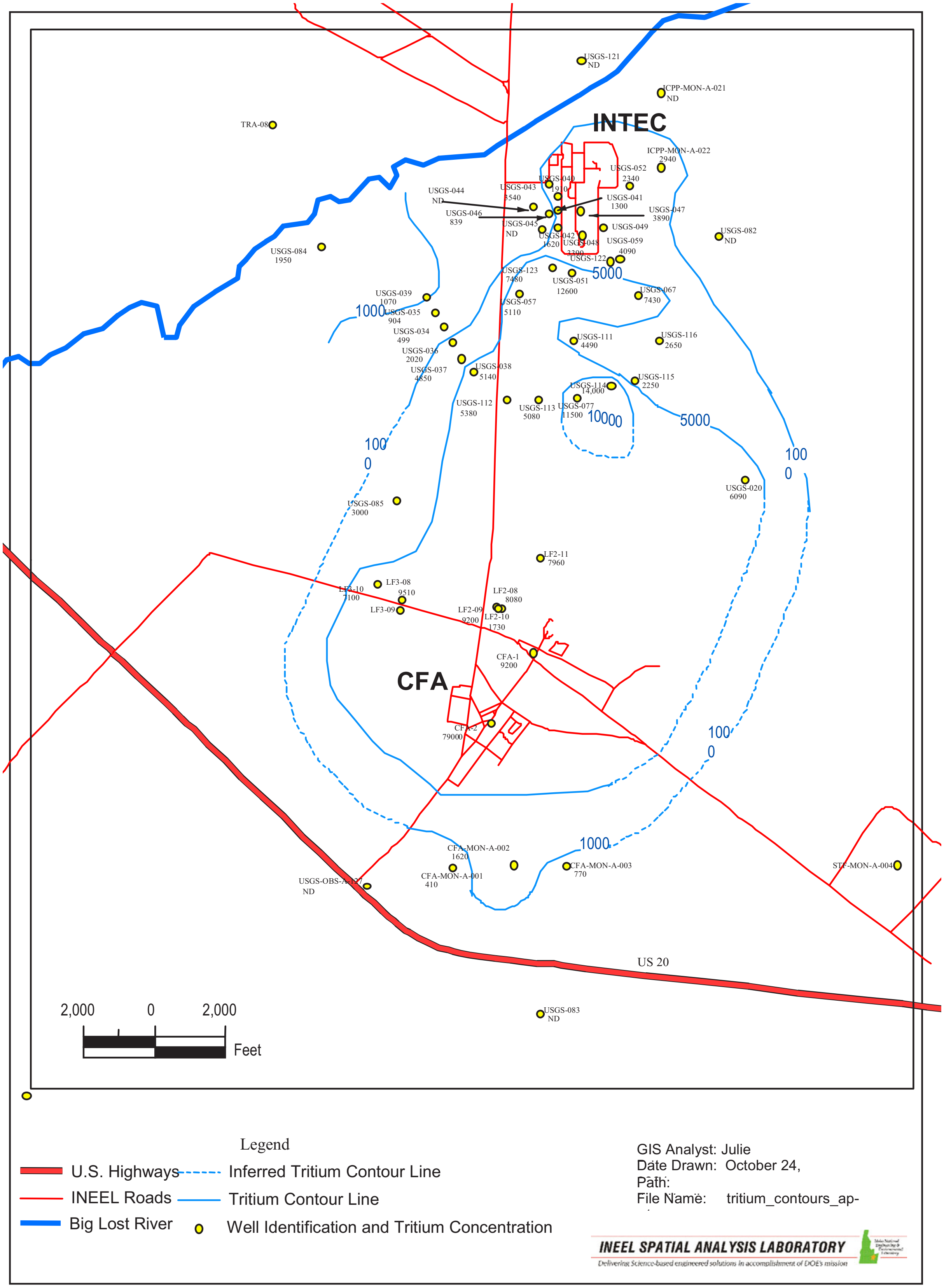

Figure 5-10. Observed tritium aquifer concentrations in 2001.

The tritium vertical sampling suggests the HI interbed may be acting as a confining layer between the deep and shallow aquifer, but concentrations are not as different as the earlier modeling indicated. Concentrations in the vertically sampled wells were higher than the model predicted without adjusting the vadose zone source term. This indicates there is a greater continuing tritium source from the aquifer than the OU 3-13 RI/BRA vadose zone model predicted. This increased vadose zone tritium flux may be due to the RI/BRA model underpredicting the rate tritium can migrate from the vadose zone or from additional and unknown tritium releases.

The current tritium contamination in the aquifer near INTEC is most likely from tritium discharged in the percolation ponds and tritium that entered the vadose zone during the injection well collapse. Approximately 16% of the total non-TRA tritium source was discharged to the percolation ponds and the injection well during the well collapse period. Tritium concentrations should decrease in the near future as vadose zone sources are depleted and radioactive decay reduces the amount of tritium in the vadose zone. The decline in tritium aquifer concentrations should be faster than the I-129 concentrations because of radioactive decay.

The model predicts tritium from the INTEC is widespread far south of the CFA. However, the current, very low contaminant concentrations in the USGS-83 well are not consistent with the current model. The current nondetect tritium concentration in this well is most likely an anomaly, because tritium sampling performed by WAG 4 in 2000 detected tritium in the USGS-104 well at 1,050 pCi/L and in the USGS-106 well at 1,110 pCi/L, which is more consistent with the model. Well USGS-104 is located approximately 3 km south of Highway 20 in a direction south of INTEC, and Well USGS-106 is located midway between the junction of Highway 20 and Lincoln Boulevard, and the Subsurface Disposal Area.

5.3.3 Technetium-99

The Operable Unit 3-13 RI/BRA Tc-99 source consisted of 2.69 Ci and is divided between 96% tank farm and 4% soil contamination. No records exist regarding the quantities of Tc-99 that might have been released into the injection well or percolation ponds; thus, these potential Tc-99 sources were not included during the RI/BRA modeling. The current model underpredicted concentrations in the vertical profile boreholes. Increasing the Tc-99 vadose zone flux improved the agreement with concentrations in the vertical profile boreholes, but increasing the vadose flux by the same 2.5 factor used in the tritium simulations overestimated the Tc-99 source by a factor 1.8 over the RI/BRA total source; therefore, this simulation was rejected.

The total Tc-99 source term was most likely underestimated in the RI/BRA modeling, because the injection well was assumed not to have received any Tc-99 during its operation. This assumption now appears to be incorrect. Historically, Tc-99 has been observed far south of the INTEC, suggesting Tc-99 was present in the service waste released into the injection well. The Tc-99 source term will need to be reevaluated with the planned update of the Group 4 vadose zone model.

Reducing the current model's aquifer basalt Kd value from 0.006 to 0.0013 and the interbed Kd value from 0.15 to 0.075 improved the agreement with the observations. The interbed Kd was reduced by a factor of 2 from that used in the RI/BRA modeling and the aquifer basalt Kd was 1/60 of the interbed value. This was needed to compensate for the larger retardation due a higher bulk density of the current model's lower basalt porosity (decreased from 6.25% of the Operable Unit 3-13 RI/BRA modeling to 3%). This is because retardation is directly proportional to the soil bulk density and bulk density is inversely proportional to porosity. Thus, the retardation will increase for a lower-porosity soil given the same K_d.

The contaminant interbed and basalt Kd values are very uncertain model parameters. The SRPA basalt and HI interbed Kd studies have not been performed and the Operable Unit 3-13 RI/BRA modeling values were estimated from studies performed on different geologic media from different sites. In lieu of performing site-specific Kd studies, adjustment of modeling Kd values was necessary to match observed conditions in the SRPA. The Operable Unit 3-13 RI/BRA modeling arbitrarily assumed basalt Kd values to be 1/25 of that for sediment. This value most likely overestimated the fractured basalt Kd. This is because the majority of flow occurs in fractures and is not in contact with the entire media. In addition, the aquifer organic content is very low.

However, the uncertainty in vadose zone contaminant flux to the aquifer will most likely have a larger effect on simulated contaminant concentrations than the Kd adjustment. The modeling Kds values will need to be reevaluated when better understanding vadose zone transport and contaminant flux to the aquifer is gained during the Group 4 vadose zone model update.

In contrast to the tritium concentrations, the Tc-99 concentrations do not indicate concentrations are substantially different above, within, or below the interbed. Figures 5-11 through 5-14 illustrate simulated Tc-99 peak aquifer concentration, horizontal concentrations at the water table in 2001, vertical concentrations in 2003, and simulated with observed in the vertical profile boreholes in 2003, respectively. The observed Tc-99 concentrations from 2001 sampling are illustrated in Figure 5-15.

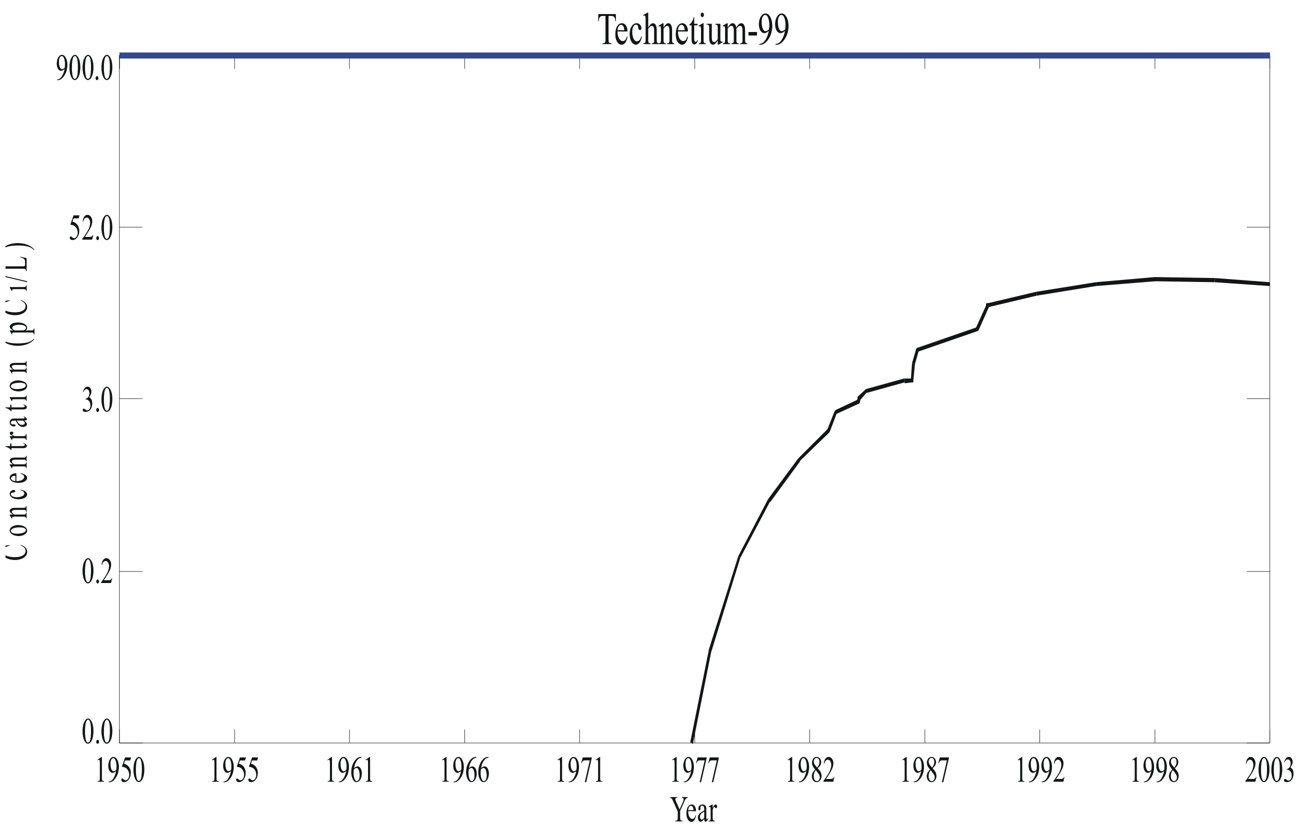

Figure 5-11. Simulated Tc-99 peak aquifer concentrations (blue line is the MCL).

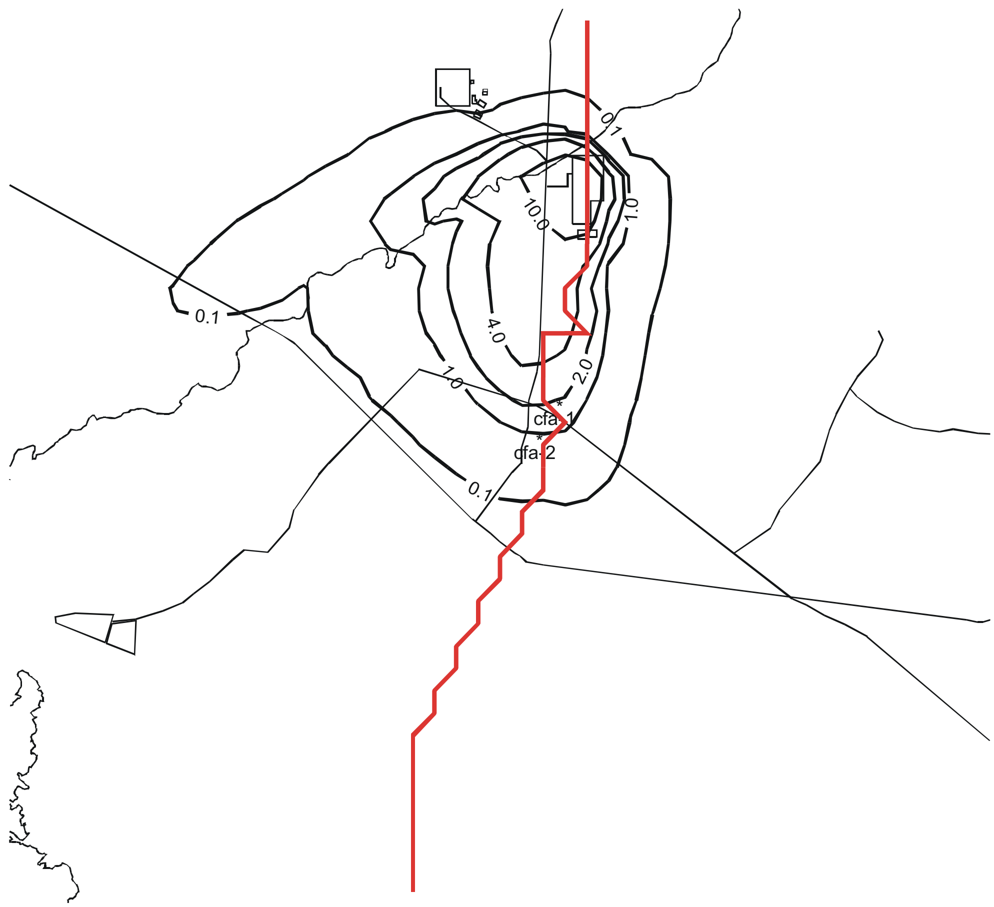

Figure 5-12. Simulated Tc-99 concentrations (pCi/L) at the water table in 2001 (the thick red line is a fence diagram cross-section for Figure 5-13).

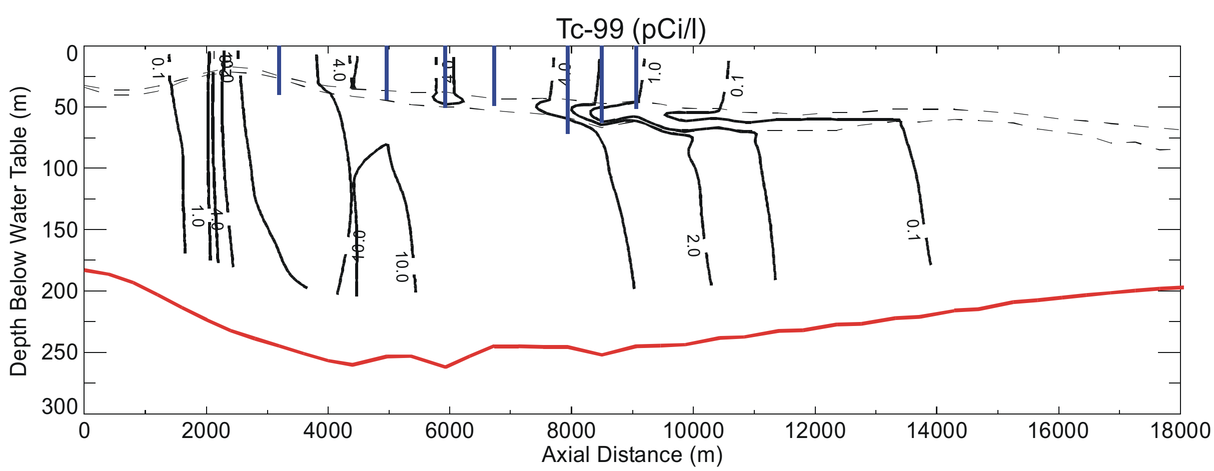

Figure 5-13. Simulated Tc-99 vertical concentrations in 2003 (the blue lines are well locations and red line is aquifer bottom).

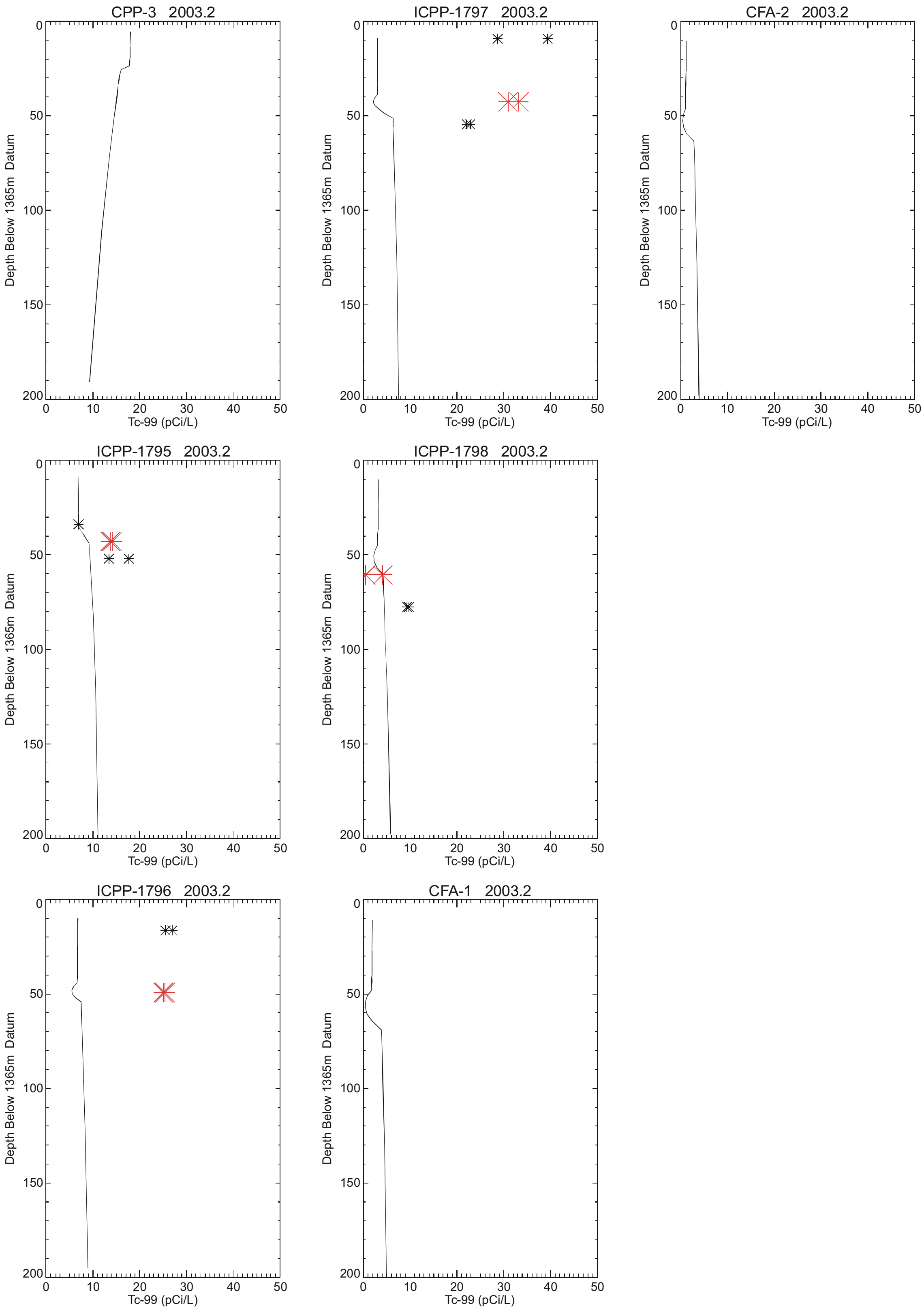

Figure 5-14. Simulated Tc-99 versus measured concentrations at vertical boreholes in 2003 (the solid line is simulated, the small asterisk is measured basalt, and the large asterisk is measured HI interbed).

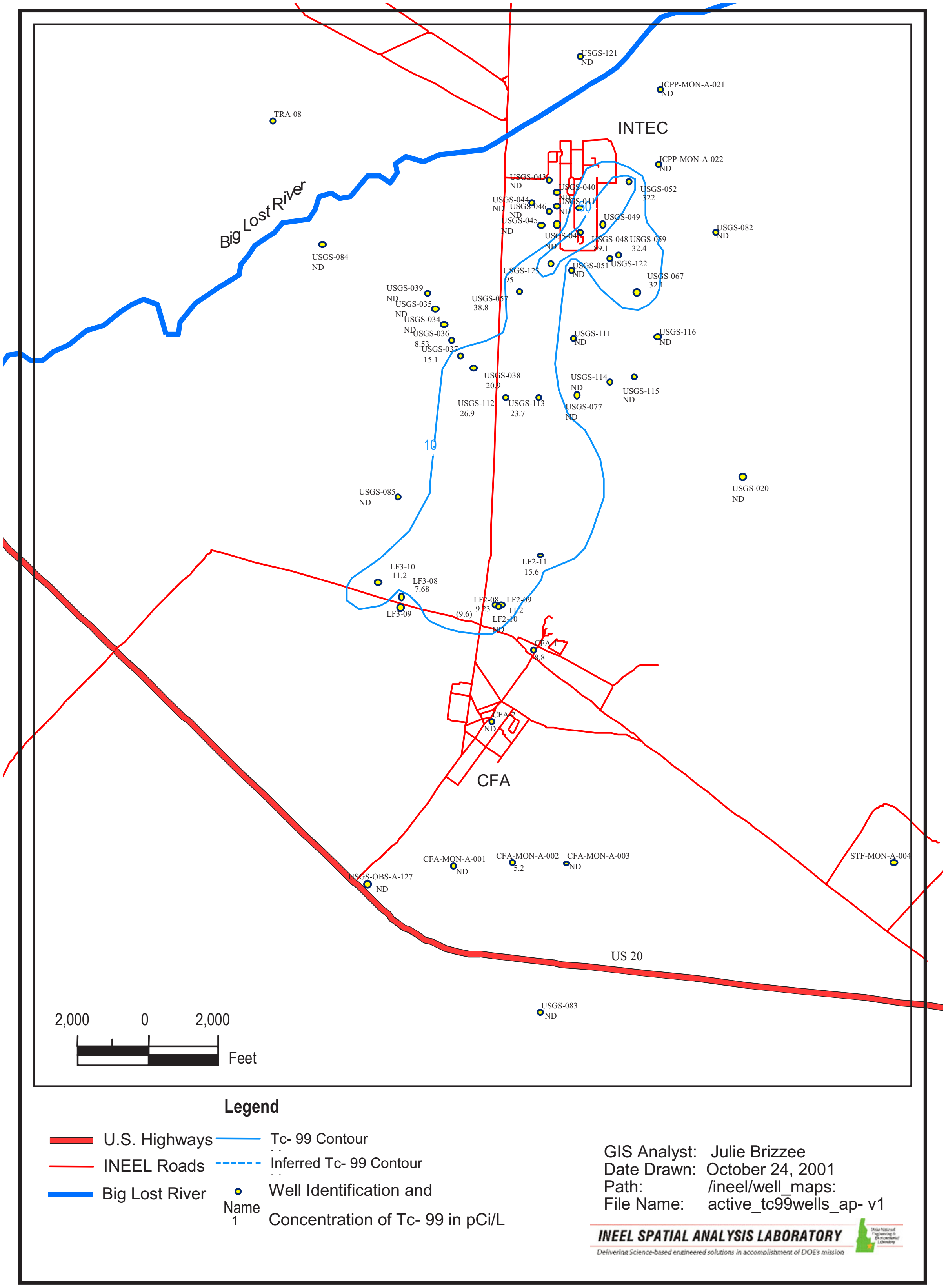

Figure 5-15. Observed Tc-99 aquifer concentrations in 2001.

Simulated Tc-99 concentrations were significantly underpredicted in the vertical profile boreholes. This may be due to the RI/BRA model overpredicting spreading in the vadose zone, thereby resulting in a vadose zone contamination footprint that is larger than that observed. The RI/BRA vadose zone model footprint extended approximately 700 m beyond the INTEC fence line in the east, west, and north directions and 1,100 m beyond the INTEC fence line in the south direction. The RI/BRA vadose zone model predicted contaminants would spread extensively in the horizontal direction, even west of the Big Lost River near TRA. This resulted in the current model overestimating the aquifer contamination in directions lateral and upgradient to the aquifer flow and underestimating peak aquifer concentrations directly beneath and downgradient of INTEC.

Simulated Tc-99 concentrations never exceeded the MCL throughout the 1954 through 2003 simulation period. The Tc-99 simulation was not performed beyond 2003 because of uncertainty in the vadose zone flux boundary condition, which needs to be better understood for predictive modeling. The simulated 2001 peak Tc-99 concentration was 21.5 pCi/L and was located near the northwest corner of INTEC. The observed peak Tc-99 concentration measured during 2003 was 2,840 ± 43.4 pCi/L in new SRPA Monitoring Well ICPP-MON-A-230. This well is located inside the INTEC, approximately 300 ft north of the tank farm's northern fence line. Because Tc-99 was detected in the aquifer at concentrations much higher than observed previously, a special investigation of the occurrence of Tc-99 at INTEC was initiated in August 2003. The final results of the Tc-99 investigation are not yet available, but will be reported in the 2004 Annual Well Monitoring Report. Preliminary results suggest that the Tc-99 appears to have been present in the SRPA beneath the northern portion of INTEC for many years. The most likely source of the Tc-99 in the groundwater in this area appears to be from past releases that occurred at the tank farm. The most likely mechanism for transport of Tc-99 to the aquifer is downward movement of contaminated water through the vadose zone to the water table. The former INTEC injection well likely constituted an earlier source of Tc-99 to the aquifer, but groundwater Tc-99 concentrations in the aquifer associated with the former injection well were far below the MCL. The INTEC vadose zone model will be revised in 2004 to better predict the migration of Tc-99 through the vadose zone to the aquifer.

5.3.4 Strontium-90

The Operable Unit 3-13 RI/BRA Sr-90 source consisted of 19,400 Ci and is divided between 92% tank farm, 6% soil contamination, and 2% other sources (including only 0.12% from the INTEC injection well). Increasing the Sr-90 vadose flux by a factor of 2.5 had no significant change in aquifer concentrations, because very little Sr-90 is predicted to enter the aquifer from the RI/BRA vadose zone model throughout the 1954 through 2003 simulation period. This is because Sr-90 is more strongly retarded in the vadose zone by adsorption than the other contaminants.

As with the Tc-99 simulations, better agreement with the observed Sr-90 concentrations was obtained by reducing the interbed Kd value from 12 to 6 and setting the aquifer basalt Kd to be 1/60 of the interbed value. This was needed to compensate for the larger retardation due to a higher bulk density of the current model's lower basalt porosity (decreased from 6.25% of the Operable Unit 3-13 RI/BRA modeling to 3%). This is because retardation is directly proportional to the soil bulk density and bulk density is inversely proportional to porosity. Thus, the retardation will increase for a lower-porosity soil given the same Kd. The Kd reduction factor is the same as that used to improve the Tc-99 simulation's agreement with the observed data. As with the Tc-99 concentrations, the observed Sr-90 concentrations do not indicate that concentrations are substantially different above, within, or below the interbed.

The simulated Sr-90 concentrations exceeded the MCL throughout the 1954 through 2003 simulation period. The simulated 2001 peak Sr-90 concentration was 19.1 pCi/L and was located 400 m southwest of the former percolation ponds. The peak Sr-90 concentration measured during 2001 sampling was 26.4 pCi/L in Well USGS-123, which is located approximately 300 m northwest of the former percolation ponds. The Sr-90 simulation was not performed beyond 2003 because of uncertainty in the vadose zone flux boundary condition, which needs to be better understood for predictive modeling.

Figures 5-16 through 5-19 illustrate simulated Sr-90 peak aquifer concentration, horizontal concentrations at the water table in 2001, vertical concentrations in 2003, and simulated plus observed concentrations in the vertical profile boreholes in 2003, respectively. The observed Sr-90 concentrations from 2001 sampling are illustrated in Figure 5-20.

The current Sr-90 contamination in the aquifer near INTEC is most likely derived primarily from the injection well even though it only accounts for 0.12% of the total Sr-90 source from INTEC. The bulk of the tank farm and soil contamination Sr-90 has not yet reached the aquifer because of retardation in the vadose zone. The injection well Sr-90 will remain near the INTEC longer than the other simulated contaminants because of retardation in the aquifer. Aquifer concentrations should decrease in the near future, but could begin to increase if surface recharge cannot be reduced during the OU 3-13 Group 4 remedial actions. As with the Tc-99 simulations, the current model Sr-90 from the vadose zone appears to be spread over a larger area than the 2001 groundwater sampling indicates.

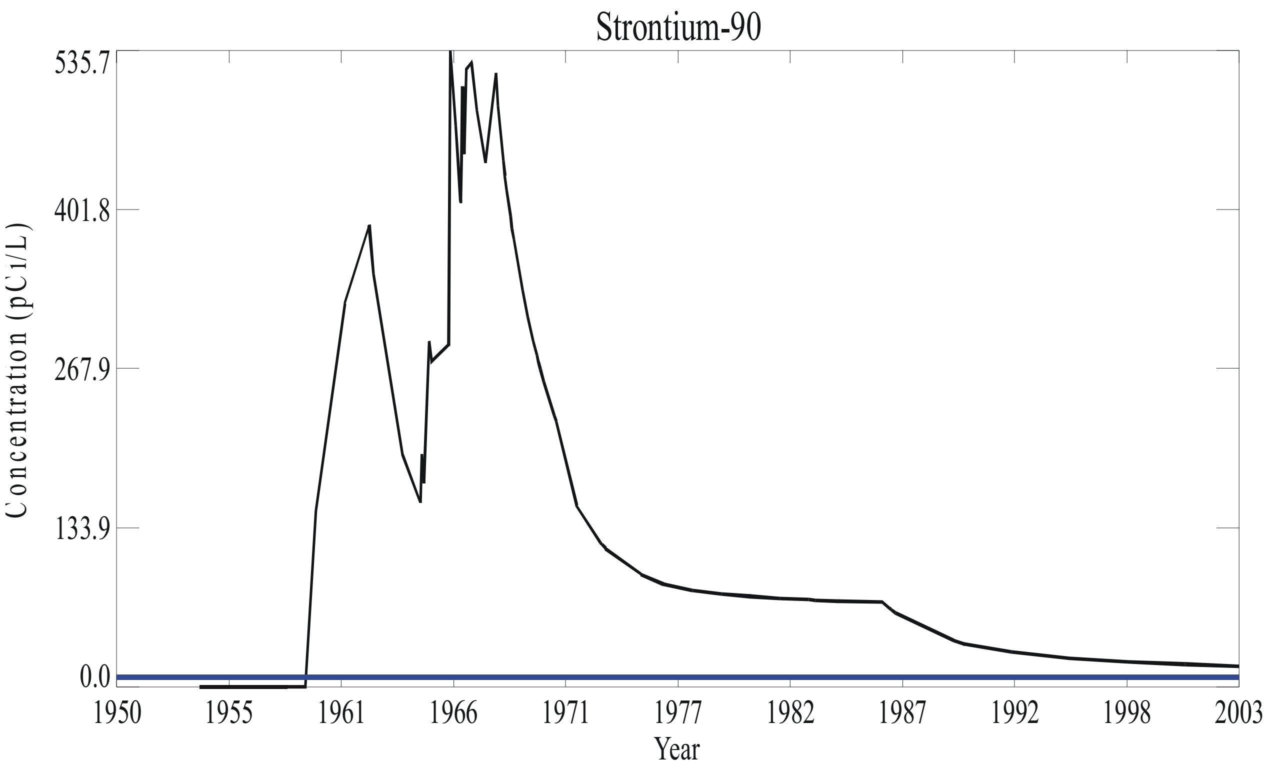

Figure 5-16. Simulated Sr-90 peak aquifer concentrations (blue line is the MCL).

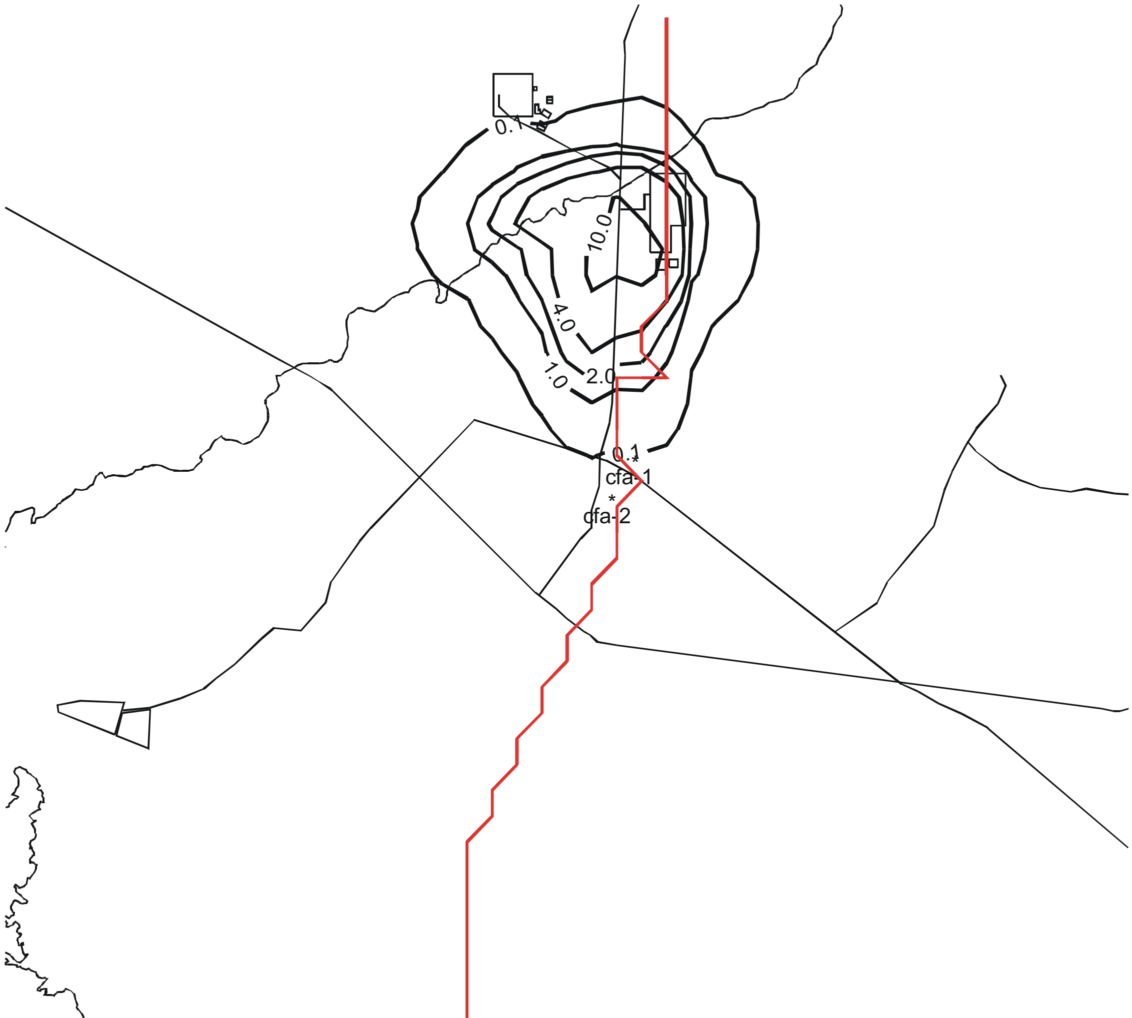

Figure 5-17. Simulated Sr-90 concentrations (pCi/L) at the water table in 2001 (the thick red line is a fence diagram cross-section for Figure 5-18).

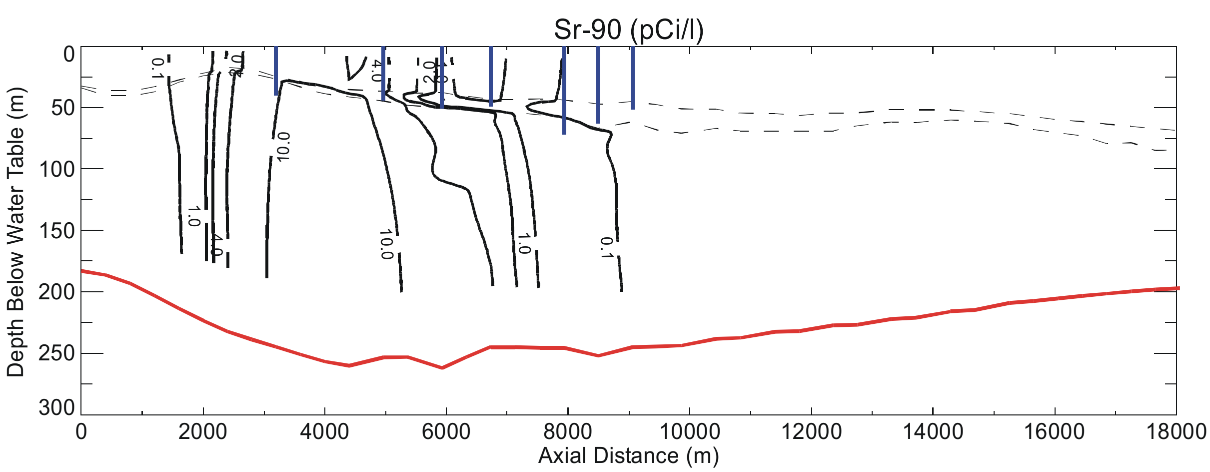

Figure 5-18. Simulated Sr-90 vertical concentrations in 2003 (the blue lines are well locations and red line is aquifer bottom).

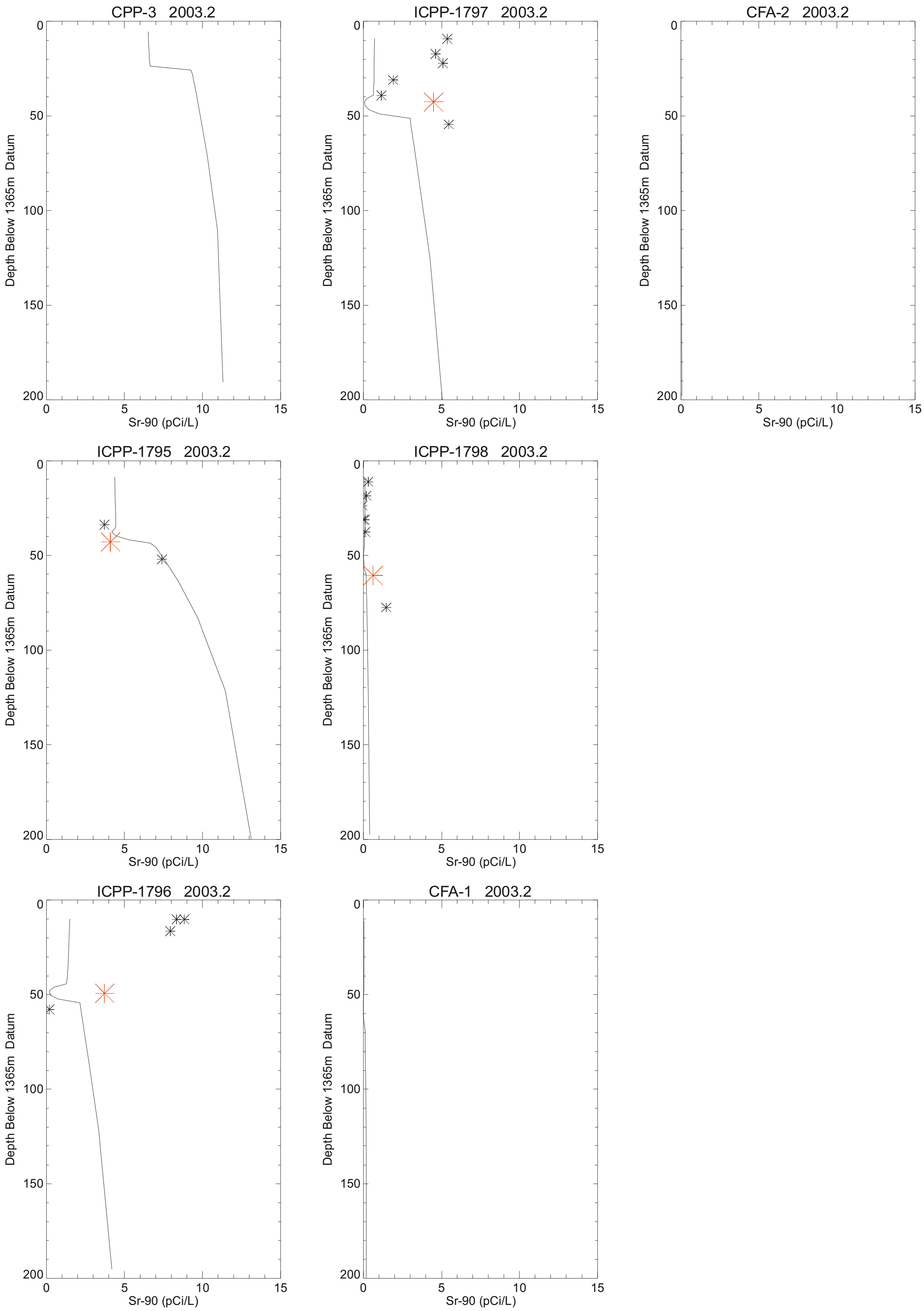

Figure 5-19. Simulated Sr-90 versus measured concentrations at vertical boreholes in 2003 (the solid line is simulated, the small asterisk is measured basalt, and the large asterisk is measured HI interbed).

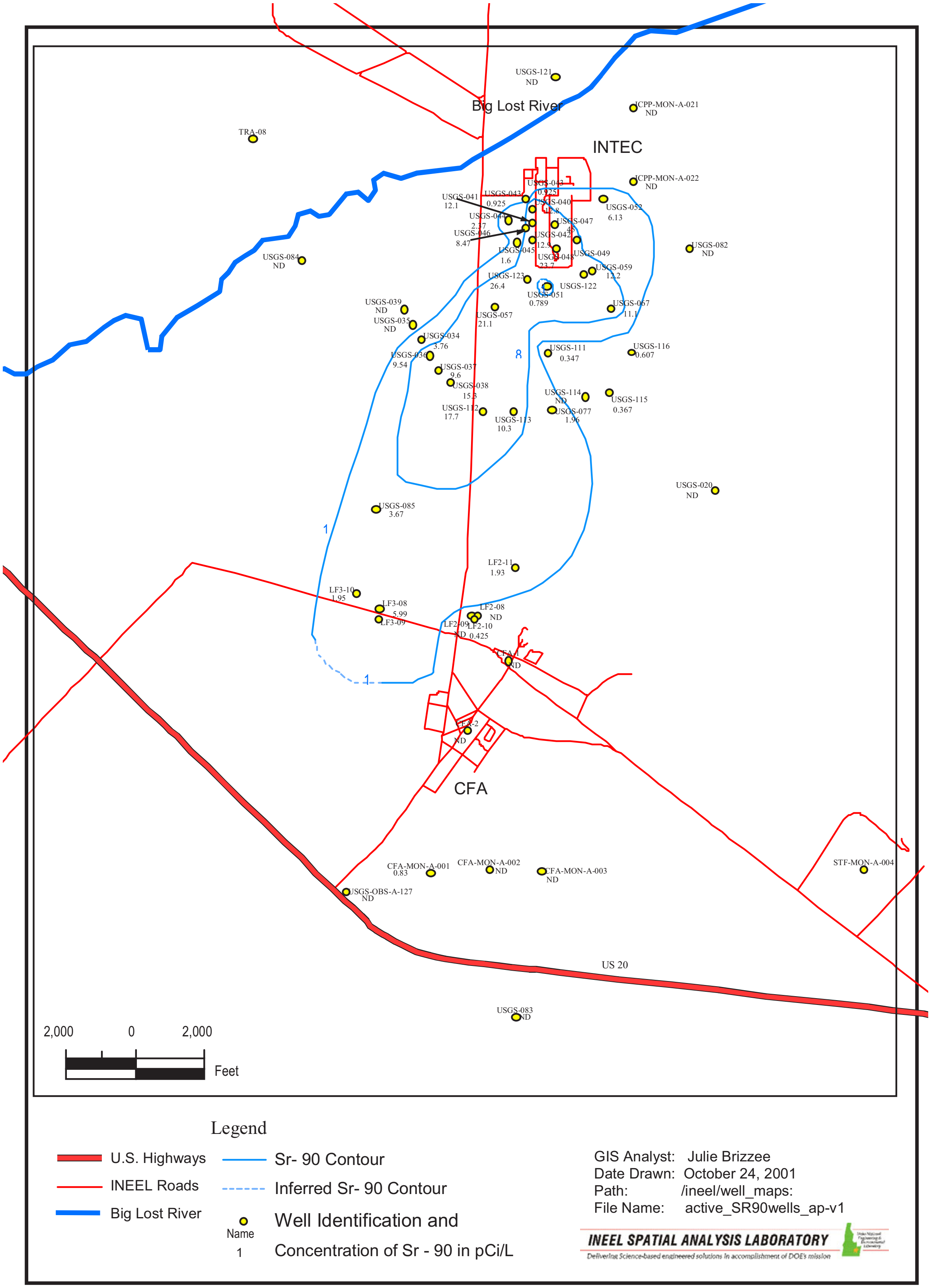

Figure 5-20. Observed Sr-90 aquifer concentrations in 2001.

6. GROUNDWATER MONITORING RESULTS AND TRENDS

Existing groundwater quality data downgradient of INTEC were reviewed to assess whether the OU 3-13, Group 5 RAO #2 will be met (MCLs met by 2095). Appendix C includes concentration trend plots for tritium, Sr-90, and I-129 concentrations reported in USGS monitor wells located near and downgradient of INTEC.

In summary, groundwater-monitoring results collected through 2003 demonstrate the following:

- Tritium activities have declined below the drinking water MCL (20,000 pCi/L) in all SRPA monitoring wells at and downgradient of INTEC.

- Iodine-129 activities have declined below the MCL (1 pCi/L) in all SRPA monitoring wells at and downgradient of INTEC.

- Iodine-129 concentrations in depth-specific groundwater samples collected by the Idaho National Engineering Laboratory Oversight Programs during 1992–1994 were less than the I-129 MCL of 1 pCi/L (McCurry and Welhan 1996).

- Strontium-90 activities in several SRPA monitoring wells downgradient of the former injection well remain significantly above the drinking water MCL of 8 pCi/L.

Groundwater monitoring results show that tritium and I-129 activities are already below their respective MCLs in all SRPA monitoring wells downgradient of INTEC. Figure 6-1 shows the I-129 groundwater plume downgradient of INTEC as it existed during 1986, 1990–1991, 2001, and 2003. The I-129 groundwater plume has diminished considerably in both areal extent and in peak concentration over this time period. Coupled with the modeling results, the observed dissipation of the I-129 plume over the past 2 decades provides strong evidence that the RAOs will be met before 2095.

The Sr-90 activities in the aquifer currently exceed the MCL downgradient of INTEC, but Sr-90 concentrations are slowly declining in all wells (Appendix C), and groundwater quality trends indicate that Sr-90 activities in groundwater outside the INTEC security fence will decline below the MCL by 2095. However, some perched monitoring wells close to the tank farm contain very high Sr-90 activities (e.g., 147,000 pCi/L Sr-90 in MW-2 in 2003). Therefore, it is apparent that vadose zone and aquifer matrix materials near the tank farm constitute a residual secondary source of Sr-90 that could potentially reach groundwater at some future time. Contaminated soil and perched water beneath the tank farm and surrounding area are being investigated and addressed under OU 3-14, and the infiltration of water through contaminated soil is being reduced in accordance with the Group 4 remedy (Institutional Controls with Aquifer Recharge Control).

Additional details regarding groundwater quality results and trends beneath and south of INTEC can be found in Appendix D, the Annual INTEC Groundwater Monitoring Report for Group 5—Snake River Plain Aquifer (2001) (DOE-ID 2002c), and the Annual INTEC Groundwater Monitoring Report for Group 5—Snake River Plain Aquifer (2003), (DOE-ID 2003c).

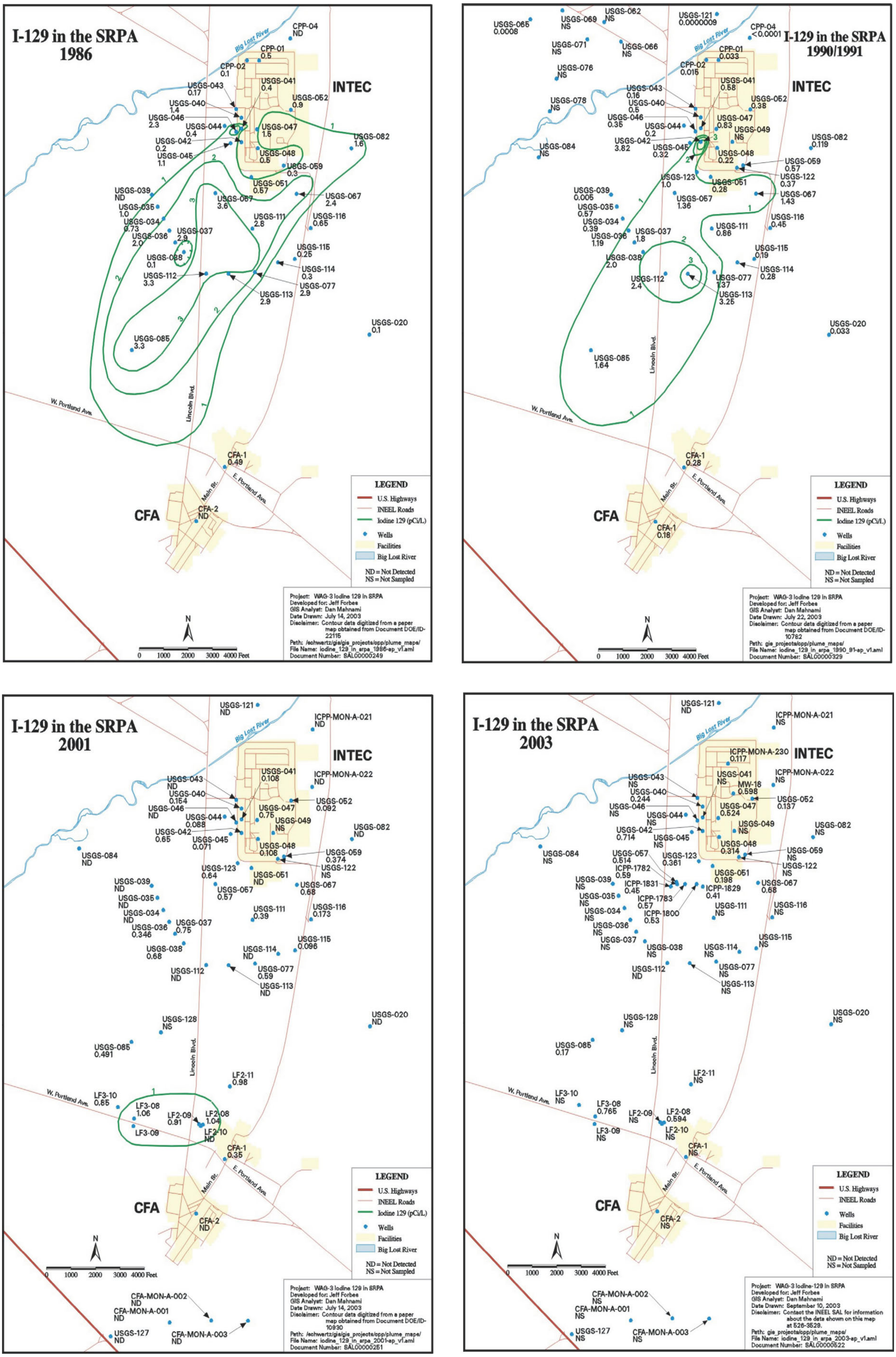

Figure 6-1. Iodine-129 groundwater plume evolution over time.

7. CERTIFICATION THAT REMEDY IS OPERATIONAL AND FUNCTIONAL

The remedy for Group 5 specified in the OU 3-13 ROD (Institutional Controls with Monitoring and Contingent Remediation) is operational and functional (DOE-ID 1999). Institutional controls are currently in place and groundwater monitoring is being performed to ensure that the RAOs for the aquifer are met. The RAOs are (1) “Prior to 2095, prevent current on-site workers and general public from ingesting SRPA groundwater that exceeds a cumulative carcinogenic risk of l × 10-4, a total HI [hazard index] of 1, or applicable State of Idaho groundwater quality standards (i.e., MCLs)” and (2) “In 2095 and beyond, ensure that SRPA groundwater does not exceed a cumulative carcinogenic risk of l × 10-4, a total HI [hazard index] of 1, or applicable State of Idaho groundwater quality standards.” The first RAO is being met by maintaining institutional control over the area of the identified SRPA contaminant plume south of the current INTEC security fence for as long as contaminant levels remain above groundwater standards or risk-based groundwater concentrations. The general actions required to meet the second RAO (post-2095) were spelled out in the OU 3-13 ROD (DOE-ID 1999).

The revised flowchart for the Group 5 remedy is shown in Figure 7-1. The flowchart shows the decision logic and key decision points reached during this plume evaluation field investigation. As shown in the flowchart, there has been no need to invoke the contingent remedy (groundwater pump and treat), and the results of groundwater sampling across the HI interbed have precluded the need for additional investigations (e.g., pumping tests, treatability studies). Based on the DQOs established for the Group 5 remedy, the flowchart shows the path forward to be periodic plume monitoring.

Both groundwater monitoring results (Section 3) and the revised groundwater flow model (Appendix B) demonstrate that the I-129 hot spot above the MCL that had previously been predicted downgradient of INTEC does not exist. Concentrations of all radionuclides of concern are declining in the aquifer (Appendix C). Therefore, assuming that the Group 4 remedy is successful in reducing infiltration through the vadose zone, there is no reason to believe that the Group 5 remedy will not be successful in achieving the RAOs established for the aquifer by the year 2095. In any case, 5-year reviews will continue to be conducted as required under CERCLA (42 USC § 9601 et seq.) to assess the effectiveness of the selected remedial alternative, to assess the need for its continuation, or to consider a different alternative, should additional information come to light suggesting that RAOs may not be achieved. The 5-year review report for OU 3-13 Group 5 will be submitted in October 2005.

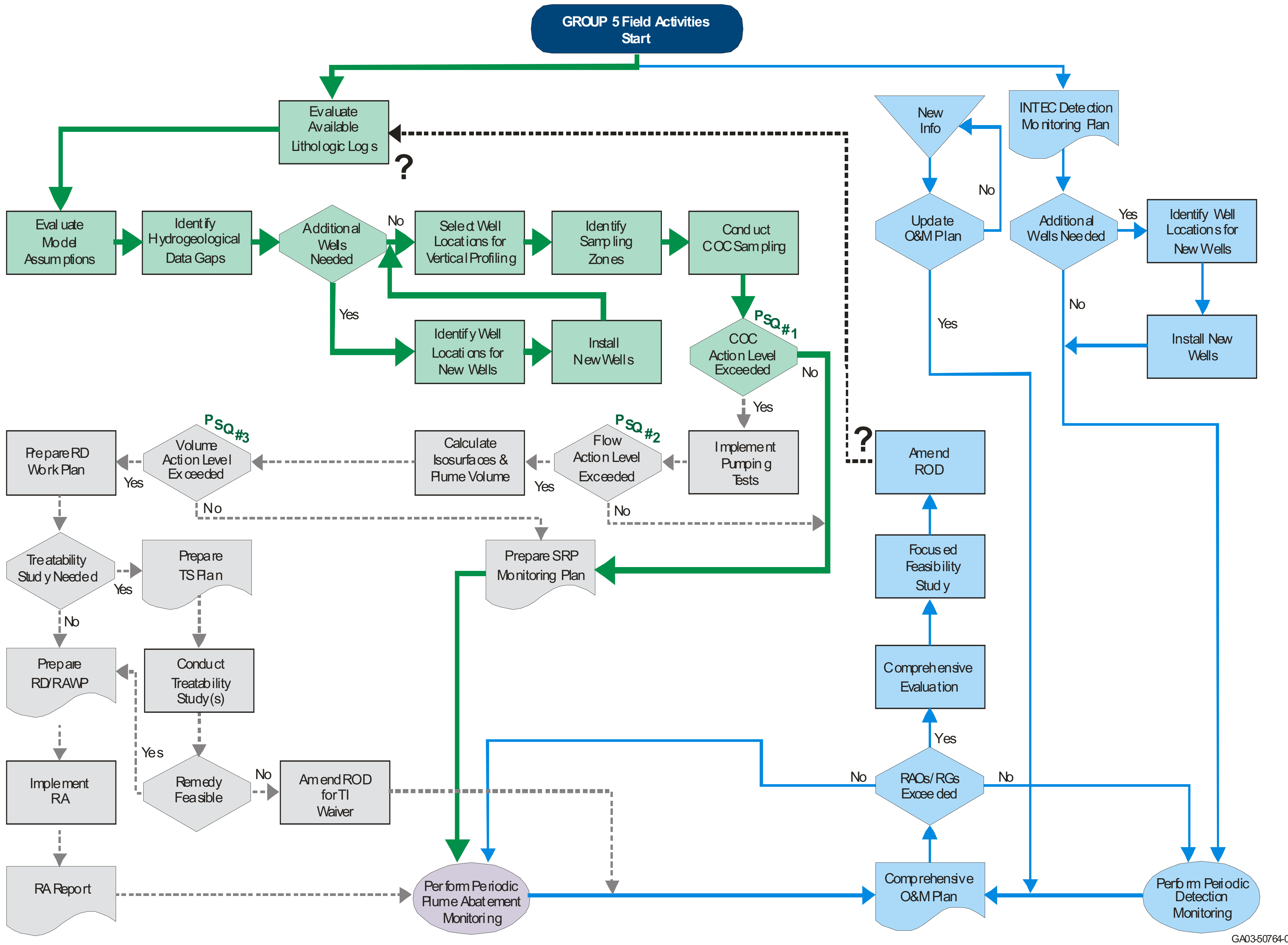

Figure 7-1. Flow chart showing decision logic for Group 5 remedy.

8. OPERATIONS AND MAINTENANCE PLAN

Remedial action reports typically include an operations and maintenance plan. With regard to the Group 5 remedy (Institutional Controls with Monitoring and Contingent Remediation), the operations and maintenance plan consists of a groundwater-monitoring schedule. This schedule is detailed in the Monitoring System and Installation Plan for Operable Unit 3-13, Group 5, Snake River Plain Aquifer (DOE-ID 2002b), and the Long-Term Monitoring Plan for Operable Unit 3-13, Group 5 Snake River Plain Aquifer (DOE-ID 2004). The Long-Term Monitoring Plan (Attachment 1) contains a list of wells to be sampled, constituents for which those samples will be analyzed, and details of the sample collection procedures. The Long-Term Monitoring Plan was revised during FY 2004 to reflect revisions to sampling frequencies and suites of analytes for individual SRPA monitoring wells.

9. PROJECT COSTS

Table 9-1 summarizes actual costs for OU 3-13 Group 5 remedial activities for the period between FY 2000 and FY 2003. Project surveillance and monitoring costs also are shown for the 92-year period remaining until the 2095 date specified in the ROD. Table 9-2 shows the costs estimated in the OU 3-13 ROD for the 100-year period assumed for the Group 5 interim remedial action.

Table 9-1. Actual project costs for Group 5 remedial action (2000 through 2003).

Fiscal Year	Actual Costs ($)
2000	$497,345
2001	$408,721
2002	$998,985
2003	$960,368
Total actual project costs (2000–2003)	$2,865,419
Projected future Group 5 costs* (2004–2095)	$15,558,120
Estimated total Group 5 costs (2000–2095)	$18,423,539

* Based on the 100-year surveillance and monitoring cost from the Operable Unit 3-13 Record of Decision multiplied by 0.92 to allow for 92 years of monitoring remaining until 2095; does not include costs for contingent remedy.

Table 9-2. Operable Unit 3-13 Record of Decision estimated costs for Snake River Plain Aquifer interim action (100 years).

Capital costs	
FFA/CO Management and Oversight	$5,300,000
Remedial design	$4,302,000
Remedial action construction	$14,855,000
Total capital cost in FY-97 dollars	$24,457,000
Operation costs	
Remedial action operations	$16,141,000
Decontamination and decommissioning of facilities	$1,647,000
Surveillance and monitoring	$16,911,000
Total operation cost in FY-97 dollars	$34,699,000
Total project cost in FY-97 dollars	$59,156,000

FFA/CO = Federal Facility Agreement and Consent Order
FY = fiscal year

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